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CONTENTS

	Page
Freedom and Obligations	507
Nature and Cognition. By Dr. R. Fürth	509
A Review of Tracer Work. By Prof. F. A. Paneth, F.R.S.	509
Low Temperature Physics. By Dr. D. Shoenberg	510
American War-time Contributions to Statistical Method. By Prof. M. S. Bartlett	510
French Palæolithic Art. By M. C. Burkitt	511
British Trade Unionism	511
Clinical Endocrinology	512
Nature Calendar. By Miss Frances Pitt	512
Genetics of Cancer. By Dr. P. C. Koller	514
The *Rh* Factor of Blood. By P. L. Mollison	515
Genetical Structure of Plant Populations	517
Application of Oxygen to Steel-making. By Dr. W. C. Newell	518
Obituaries:	
Prof. S. W. J. Smith, F.R.S. By Prof. M. L. Oliphant, F.R.S., and A. A. Dee	519
King Ferdinand of Bulgaria. By Phyllis Barclay-Smith	520
News and Views	521
Letters to the Editors:	
Structure and Biogenesis of Emetine.—Sir Robert Robinson, F.R.S.	524
A Synthesis of Pteridine.—Dr. W. G. M. Jones	524
Chemical Assay of Streptomycin & (Mannosido – Streptomycin).—W. B. Emery and A. D. Walker	525
Molecular Weight of Malt-Amylase.—Carl-Erik Danielsson	525
Action of Oxalyl Chloride on the Aromatic Hydrocarbons.—Hussein Ahmad Fahim	526
Selective Development of Fission Tracks in an Electron-sensitive Emulsion.—Dr. G. W. W. Stevens	526
Anomalous Magnetic Behaviour of Nickel–Iron at High Frequencies.—A. Wieberdink; Prof. R. Kronig	527
Brief Light Pulses using Kerr Cells.—Prof. W. M. Cady and A. M. Zarem	528
Liquid Surface Interferometry.—H. Barrell and R. Marriner	529
Truncated Log-Normal and Root-Normal Frequency Distributions of Insect Populations.—D. Spiller	530
Photographic Evaluation of Blackout Indices.—Dr. Robert W. Lawson	531
Variation of Ground-Levels on Coe Fen, Cambridge.—E. G. Sterland	532
Work-Hardening Under Complex Stresses.—Dr. K. H. Swainger	532
Genetics of Style-Length in *Oxalis*.—Prof. R. A. Fisher, F.R.S., and V. C. Martin	533
Microflora of the Rumen of the Sheep.—M. Ingram and C. A. McGaughey	533
British Folliculinidæ (Ciliata, Heterotricha).—Dr. S. M. Das	534
Number of Sperms Required for Fertilization.—C. R. Austin	534
Inactivation of Complement by Nitrogen Mustard.—W. M. Watkins and Prof. A. Wormall	535
Loss of White Cells in Bone Marrow Culture.—H. J. F. Cairns and L. G. Lajtha	536
Effect of Adenosine Triphosphate on Monolayers of Myosin.—Agnete Munch-Petersen	537
Paramagnetic Resonance in Copper Sulphate:	
Experimental Investigation. By D. M. S. Bagguley and Dr. J. H. E. Griffiths	538
Theory. By Prof. M. H. L. Pryce	539
Royal Observatory, Greenwich	540
Resistance to Sulphadiazine and 'Paludrine' in the Malaria Parasite of the Fowl (*P. gallinaceum*). By Dr. Ann Bishop and Elspeth W. McConnachie	541
Changing Aspects of Nutrition	543
International Commission on Large Dams: Congress in Sweden.—By Dr. Norman Davey	544

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FREEDOM AND OBLIGATIONS

IN the summary of the proceedings of the meeting of the Committee on Science and its Social Relations held in Paris during June 15–16 which has been sent to the scientific press and to scientific organisations, special emphasis is placed on a declaration on the principles of a charter for men of science. This declaration is the outcome of a discussion on the obligations and rights of scientific men in which due note was taken of the charter proposed by the World Federation of Scientific Workers and of a resolution adopted by the General Assembly of the International Council of Scientific Unions in London in July 1946. This resolution, which arose out of discussions on research on nuclear energy, affirmed the conviction of the International Council that international security and welfare would be impossible if in any country military secrecy be allowed to dominate scientific discovery or to prevent the frank discussion and open publication of scientific results. Accordingly, the General Assembly, in the name of the men of science of the nations represented, acknowledged in this resolution the duty on the part of scientific workers : (*a*) to maintain a spirit of frankness, honesty, integrity and co-operation and to work for international understanding ; (*b*) to promote the development of science in the way most beneficial to mankind and to exert their influence as far as possible to prevent its misuse ; (*c*) to serve the community not only by their specialized work but also by assisting so far as they are able the education of the public in the purposes and achievements of science.

The declaration now issued by the Committee on Science and its Social Relations points out that the prominent position held by science in society and the rapid transformation of the world through the application of science carry with them, for scientific workers, special obligations over and above the ordinary duties of citizenship. The Committee lists among these obligations the first two recorded in the resolution from the International Council of Scientific Unions, and adds three others : to examine consciously the meaning and purposes of the work that he or she is performing ; when in the service of others to inquire into the purpose for which the work is being done and the moral issues that may be involved ; and to assist in the education of the people and government in the purposes and the achievements of science. Furthermore, to fulfil these obligations, the Committee urges that it is necessary to claim certain rights for scientific workers, and especially : (i) freedom of publication and the utmost freedom to discuss one's work with other men of science ; (ii) economic security and the right to participate freely in all activities permitted to all citizens ; (iii) the possibility of obtaining information about the purposes for which his or her work is being done.

Now the obligations detailed by the General Assembly of the International Council of Scientific Unions are clearly in line with the rights defined in the United Kingdom draft of an International Bill

of Human Rights, as well as with American opinion in this field, and are the counterpart of the freedom of speech and publication and information set forth in that draft, though it should be noted that however admirable the sentiments it is not easy in practice to give precise meanings to some of the terms. There may well be acute differences of opinion in interpretation and even sharp dispute. The further obligations and rights detailed in the new declaration from the Committee on Science and Social Relations, however, bristle with such difficulties and require very careful scrutiny before they can be accepted for what they purport to be and held universally valid.

In the first place, when the proposed charter substitutes an over-riding professional loyalty, something in the nature of a Hippocratic oath, for the strong national loyalties of to-day, it is as well to be quite clear as to the consequences. Something of what may arise is indicated by the circumstances in Britain which last spring forced the Government to exclude from a certain range of appointments Communists and others whose particular political loyalties were suspect of over-riding national loyalties. Though there may be a large measure of international agreement on the traditional loyalty of any profession, it is imperative, in a world where international loyalty itself has commonly so little force, that national loyalties should not be disregarded too lightly, however untoward some of their consequences may be.

The framers of this declaration obviously had in mind the increasing use of science for military ends; but they do not appear to have taken sufficient account of the position of the individual scientific worker. It cannot seriously be maintained that the professional organisation of even, say, chemists is sufficiently strong and virile to afford a chemist the support and anchorage anywhere in the world which will enable him in any circumstances to refuse to work for military ends. If, say, under a dictatorship, persecution or other means compels him to do so, while in democracies and elsewhere he refuses to do so, the practical result might be the overthrow of the democracies and probably of science with them.

Viewed from this angle and without other measures, the charter might well be of no more value than the Kellogg Pact. The work of most men of science, however, is not primarily or even secondarily connected with preparations for war. Most of them are engaged in some form or other of work in industry, and the terms in which the obligations and rights of the scientific worker are set forth by the Committee on Science and Social Relations seem to take very imperfect account of that fact. The freedom of publication and freedom to discuss his work with other men of science must in industry be subject to some limitations. In practice, industry in Britain does pursue an increasingly liberal policy towards publication of research results; but while, for example, the practice of patenting remains, there are clearly other considerations, and the responsibility for decision as to publication and public discussion must remain one for management. Indeed, the claim that the man of science should be fully informed about the purposes for which his work is required makes it more essential from the point of view of industry that the management should retain the responsibility for decision as to publication. The whole trend of thought and policy is towards giving all workers more information as to the reasons for the work as the best means of securing wholehearted co-operation, and the Barlow Report on Scientific Staff and other reports have emphasized the importance of taking scientific and technical staff into the full confidence of the management. The wisdom of that practice was demonstrated repeatedly during the War in the case of what is commonly described as 'operational research'.

That, however, is reciprocal. The confidence of management in the scientific worker must be met by a readiness on the part of the scientific worker to respect that confidence, and by the understanding that there are times when it is not in the public interest to disclose information acquired in confidence. The disclosure of confidential information cannot be claimed as a right, above all in the face of a formula which almost enjoins a scientific worker so minded to pry into the whys and wherefores of what he is doing. While very few would be likely to abuse such a right, no commercial firm could be expected to tolerate the absurd position which might arise, and any charter intended for universal acceptance must have regard to the conditions of every life in which the rights and responsibilities it adumbrates will be exercised.

What sometimes appears to have escaped the minds of those responsible for drafting the present charter is that freedom and rights are contingent. Seldom, if ever, can they be regarded as absolute. That much was implicit in the United Kingdom draft of an International Bill of Human Rights, and discussions at Geneva and elsewhere have indicated not only the difficulty of giving precise definition to rights which could be legally enforceable, but also the value of a declaration as opposed to a legally binding international agreement. A declaration which, without being Utopian, represented the practice of the most advanced countries might be accepted sincerely as a standard, and may well prove to be the most satisfactory solution to the problem so far as it touches men of science.

Much searching and honest thought will have to be given to the problem if a set of formulæ is to be derived which can command universal assent and respect without being too vague to be of value. The present declaration cannot be regarded as more than a contribution to the discussion, if indeed it were ever intended as more. At least it deserves to be examined and criticized constructively by those more familiar with the problems of industry and competent to assess the position of the industrial scientific worker than the members of the Committee on Science and its Social Relations itself would appear to be. The ethical and moral basis of world order and international co-operation will not be achieved without an intellectual effort at least comparable with that through which the discipline and tradition of any profession have been developed.

NATURE AND COGNITION

Natur und Erkenntnis

Die Welt in der Konstruktion des heutigen Physikers. Von Prof. Arthur March. Pp. viii + 239. (Wien: Springer-Verlag, 1948.) 21*s*.

THE author, who is well known as one of the pioneers in the field of quantum theory, has in this book made the attempt to present the fundamental ideas of modern physics without the use of mathematics in such a way that an intelligent reader could really understand their implications. For this purpose it is of paramount importance to analyse in everyday language the hidden meaning of the mathematical formalism. This is a tremendous task, and it seems doubtful if readers who have no knowledge of higher mathematics can in this way be made to understand what is meant by infinite matrices, eigenvectors, invariants, etc. A few chapters are devoted to the discussion of the nature of particles and of waves, and the author makes every effort to explain the apparent contradiction between the two aspects of one and the same phenomenon. In spite of this, I think, the average reader will sometimes feel rather giddy from the exertion of having constantly to change his angle of view during complicated discussions, like the one on the meson theory of nuclear forces.

The most important part of the book is that in which the author attempts to explain, in a generally intelligible way, the idea of a fundamental smallest length in Nature, and in his foreword he confesses that he has written the book mainly for this purpose. As the Planck constant h restricts the detailed description of events and reduces them to 'elementary acts', similarly the existence of a smallest length l_0 restricts the measurement of space (and consequently of time), and puts a limit to the analysis of space and time relations. It is shown how by the introduction of this new principle certain serious difficulties concerning the interaction of fields and particles can be removed satisfactorily.

The author also tries to make the reader acquainted with the philosophical implications of the quantum theory. His own attitude as that of a 'phenomenologist' is to object to the use of 'not measurable' quantities in a physical theory although he raises no objections against the use of continuous coordinates (which are not measurable according to the principle of a smallest length) or against the use of complex wave functions (which are not 'observable' quantities in quantum mechanics). He maintains that present-day quantum theory already provides the fullest possible description of the physical world and that we simply have to accept as a not further explicable fact that the individual phenomena are not subject to the law of causation, but that it nevertheless applies to mass phenomena. This sounds rather like Du Bois Reymond's defeatist "ignorabimus", and the majority of scientific men will prefer Hilbert's famous motto: "We must know and we shall know".

The book is not intended to describe the historical development of the ideas to which it is devoted, and so the names of the discoverers of the most important facts and ideas are only casually mentioned. But certain omissions are to be regretted; although, for example, the statistical interpretation of quantum mechanics forms one of the main fundamentals of the author's discourse the name of the originator of this idea, Max Born, is not even mentioned. The inclusion in the book of a short historical review with names and data and references to original literature, and an index of subjects and authors would certainly increase its value.

The book makes very enjoyable reading because of the charming way in which the subject is presented, although it was written under most distressing external conditions. It is to be hoped that it will be translated into English so that it may become available to a broader public in this and other countries.

R. FÜRTH

A REVIEW OF TRACER WORK

Dix ans d'application de la radioactivité artificielle

By Dr. Pierre Süe. Pp. 258. (Société d'Éditions Scientifique, Paris, 1948.) 675 francs.

THE Scientific Information Conference held by the Royal Society during June 21–July 2 has directed the attention of wider circles to the importance of the work of abstractors and reviewers for the progress of science. One of the Conference's recommendations was that "senior scientists should regard the provision of reviews as an important ancillary to the pursuit of new knowledge". It is obvious that the need for such help is greatest in rapidly expanding branches of science, as, for example, radioactivity.

That scientific workers in other countries are of the same opinion is shown by the survey on the use of radioactive tracers just published in Paris. The author is Dr. P. Süe, research director in Prof. Joliot's Laboratoire de Chimie Nucléaire. It represents a practically complete compilation of the relevant literature up to September 1947. The essential part is a chapter in which the material is arranged according to the subject of the researches; if the title of a paper does not seem sufficient, a brief summary of its content is added. Only the author of the paper and a number are given in these tables; the bibliographic reference is to be found in the succeeding alphabetic list of author names. If there are several authors, only the first one is mentioned, which makes it, unfortunately, impossible to trace in this way the other authors whose existence is indicated by an "et al." only. A third list which will frequently prove helpful arranges the papers according to the radio-elements used.

The book begins with a survey of all radioactive nuclides, based largely on the well-known tables published by Prof. G. T. Seaborg in 1944. The fact that the author found it advisable to reproduce, for the benefit of his readers, so much published material shows very clearly the present weakness of our arrangements for the distribution of scientific information; for the re-setting of such complicated tables is an unpleasant task where the danger of misprints can only be avoided by very time-consuming proof reading. However, the printers and correctors seem to have been very successful, more so here than in other parts of the book; but for the errors which do occur in this first edition, certainly no excuse is needed. One regrets that, besides misprints, different types of lettering have sometimes been used by the printer without any apparent reason, and that there is no clear system in abbreviating the titles of the scientific journals, one and the same appearing under very varied contracted forms. It would no doubt have been useful to add a list of the

abbreviations used, especially as some of the rarer ones can scarcely be interpreted by the average reader, and the understanding of others is made more difficult by printers' errors.

So long as the compilation of such reviews remains the arduous task of busy research workers they will always have to choose between the two evils: of allowing a number of inconsistencies and errors to remain, or to delay publication with the risk that some of the material will already be out of date when the book appears; the only way out of this dilemma seems to be the preparation of such reviews by permanent staffs of professionals and, if possible, in an international organisation. Pending that, the very comprehensive and well-arranged bibliography given to us by Dr. Süe will be found most useful by all laboratories working on radioactive tracers. Nothing equivalent seems to exist yet in the Anglo-American literature, although the bibliography contained in Appendix 5 of the Fourth Semiannual Report of the U.S. Atomic Energy Commission, which lists all papers on isotope utilization that have recently come to the attention of its Isotopes Division, is similar in arrangement.

F. A. PANETH

LOW TEMPERATURE PHYSICS

Low Temperature Physics

By Dr. L. C. Jackson. (Methuen's Monographs on Physical Subjects.) Revised second edition. Pp. vii + 130. (London: Methuen and Co., Ltd., 1948.) 6s. net.

THE great attraction of low temperature physics as a field of research is that so many of the phenomena still lack any fundamental theory, so that the outcome of any new experiment is rarely a foregone conclusion. The outstanding phenomena at present requiring something deeper than 'phenomenological' theories are superconductivity and the properties of liquid helium, and other as yet unsuspected phenomena may come to light when the new range of low temperatures below 1° K. is properly exploited. The interest of these problems was beginning to be more widely recognized just before the War, and with the resumption of scientific work after the War there has been a great expansion, particularly in the United States, of the facilities necessary for research at temperatures within a few degrees of the absolute zero.

The appearance of a second edition of Dr. Jackson's excellent monograph is thus particularly timely, both because of this increased interest and of the considerable advances made since the first edition appeared in 1934. Dr. Jackson, who was a pupil of Kamerlingh Onnes at Leyden some twenty-five years ago and is at present in charge of cryogenic work at Bristol, writes with the authority of first-hand experience. The treatment (which is essentially the same as in the first edition, but brought up to date) combines very successfully an account of the general principles of each topic discussed with just sufficient practical detail and numerical data to make the description come alive; theoretical results are not usually derived in detail but enough is said to give a qualitative idea of where they come from, and references to more detailed treatments are indicated. In such a short book it is impossible to cover more than a selection of topics, and a wise choice has been made both of subjects which are of interest as topical problems and those needed as a background to appreciate the significance of the latest work. After two introductory chapters on the production and measurement of low temperatures, the main headings are the properties of helium, specific heats in general, electrical conductivity (including superconductivity) and magnetism. Not only may the book be warmly recommended as an excellent introduction for the final honours student or the intending research student, but it may also be read with benefit as a well-balanced survey by those already working in the field.

D. SHOENBERG

AMERICAN WAR-TIME CONTRIBUTIONS TO STATISTICAL METHOD

Selected Techniques of Statistical Analysis for Scientific and Industrial Research and Production and Management Engineering

By the Statistical Research Group, Columbia University. Edited by Churchill Eisenhart, Millard W. Hastay and W. Allen Wallis. Pp. xiv + 473. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 36s.

IN the United States, as in Great Britain, the value of statistical method and technique became especially recognized during the War. This was an inevitable outcome of need, but is perhaps also some tribute to the contributions of the comparatively few statistical workers. The Statistical Research Group of Columbia University worked for the Applied Mathematics Panel, Office of Scientific Research and Development. One of its major contributions to technique was sequential analysis, the subject of an independent monograph recently prepared by its principal creator, A. Wald. The editors of the volume under review had the rather difficult task of assembling other much more miscellaneous work, which arose as "almost a by-product of the responsible and co-operative handling of practical military, scientific, engineering, and production problems".

They have done this with a series of more or less self-contained and independently written chapters by various authors. These have been arranged in three parts: the first, on "Industrial Statistics", including two long chapters by W. Allen Wallis on the "Use of Variables in Acceptance Inspection for Percent Defective" and by Harold Hotelling on "Multivariate Quality Control, Illustrated by the Air Testing of Sample Bombsights"; the second, on "Planning Experiments"; and the third on "Techniques and Tables". Unfortunately this arrangement is at times extremely arbitrary; for example, it is not very obvious why two technical investigations by Churchill Eisenhart on the "Effects of Rounding or Grouping Data" and the "Inverse Sine Transformation of Proportions" should be allocated to different parts. The references to sequential analysis seem unsatisfactory, an elementary account by Wallis concluding the volume, whereas the first chapter includes a sequential problem of strictly more complex type.

Such limitations cannot, however, be entirely avoided in an *ad hoc* collection of this kind. Provided it is not regarded as a text-book, but as a record of miscellaneous work, it serves two purposes: (1) as a reference book (with some useful tables and charts, and an almost too exhaustive index); (2) as an indication of the potential value of such techniques, in

peace as well as in war, to its intended readers—"scientists, engineers, managers, and statisticians". One may wonder how much the middle two, at least, of these groups like the presentation, and might not have preferred the technical notes concluding some of the chapters to have spread to cover most of the exposition, leaving a simple introduction in each case to summarize the article. This would, however, have meant still more editing to meet a rather speculative requirement, for many engineers and industrialists have by now recognized the value of statistical techniques and do not need to be so spoon-fed. Perhaps before long even the claim in the preface that "the chemical, physical and engineering sciences are, on the whole, distinctly backward in the statistical planning of experiments and the analysis of empirical data, at least by comparison with the social, biological, and agricultural sciences" (compare the war-time success of biologists in the kindred subject of operational research) will no longer be tenable.

M. S. BARTLETT

FRENCH PALÆOLITHIC ART

Le centre préhistorique de Ganties-Montespan (Haute-Garonne)

Par Félix Trombe et Gabriel Dubuc. (Archives de l'Institut de Paléontologie humaine, Mémoire 22.) Pp. 128. (Paris: Masson et Cie., 1947.) 1,200 francs.

THIS *Mémoire* of the Archives de l'Institut de Paléontologie humaine deals with palæolithic art discovered in the side galleries of an underground river by Monsieur Casteret in 1922. Near the little village of Ganties in the region of Saint Gaudens to the south of the River Garonne there occurs a sort of natural reservoir at the base of a low chain of limestone hills which separate Ganties from another little village, Montespan. During æons of time the waters which accumulate in the 'reservoir' have filtered through the limestone hills, eventually forming an underground river which comes out at Montespan to form a small tributary of the Garonne.

During the exceptionally dry summer of 1881 the water in the 'reservoir' fell so low that the underground river was for the first time disclosed and partially explored. Since then the water always stood too high and no further exploration was possible until 1912, when an artificial entrance was made. In 1922, however, Monsieur Casteret dived under a siphon at the Montespan exit and started to explore the underground river from that end. In some dry side galleries he came upon examples of palæolithic art—engravings, clay tracings and modelling, etc.—and these have now been made more accessible. In the vicinity are some rock-shelter 'homes', where traces of upper palæolithic man's handiwork, including some examples of the 'home' art, have been found.

Monsieur Casteret found no strikingly beautiful works of art, nor do paintings occur; no lovely painted bisons like those in the cave of Niaux, which is not so very far away, were discovered, but the finds are none the less of considerable interest. Some of the engravings, judging by their style, were probably the work of Aurignacian man, as too were most of the tracings in clay which recall closely those of the cave of La Clotilde in northern Spain. The rest of the engravings would seem to be early Magdalenian in date. The discovery of the body of a cave bear modelled in clay raises some interesting problems. It had no head and it would seem may have been used as a stand over which the skin and head of a real bear could be thrown. This appears to have been used as a target, and many of the arrows, penetrating the skin, have left marks in the clay underneath.

The volume gives a full account of the site and the history of the discovery, and the prehistoric art is fully described and illustrated. As is true for almost all the *Mémoires* of the Archives de l'Institut de Paléontologie humaine, it is indispensable for the student of prehistory, and this is especially true if his interests are particularly focused on the upper palæolithic art.

M. C. BURKITT

BRITISH TRADE UNIONISM

British Trade Unionism

Six Studies by P.E.P. Pp. vii+184. (London: P.E.P., 1948.) 15*s*. net.

IN several broadsheets, notably that on "Output and the Worker", in April 1945, "Inside the Unions", in May 1946, and "Framework of Collective Bargaining", Political and Economic Planning has already examined problems confronting the trade unions and their position in a society organised for full employment. The present report carries that examination a stage further. It is primarily a factual study of British trade unions and their place in industrial relations, and is intended rather to provide a firm foundation for the future study of policy than to indicate solutions to the numerous vital problems which it brings into the light of public discussion. The wider interest of the study, moreover, is derived from the relation of the inquiry and the discussion it seeks to stimulate to the larger problem of active democracy on which *Planning* is simultaneously engaged.

The six studies comprising the present volume cover first the structure of the trade unions, their size, hierarchy and the characteristics of union membership at the three levels distinguished in the earlier broadsheet: the national officials, the active branch membership and the rank and file. In emphasizing the dynamic human relationships, this study makes a welcome contribution to a wider and more sympathetic understanding of the unions on the part of the general public. This contribution is the more important as much of the second study is perforce purely descriptive, and the outline it gives of the formal machinery of negotiation loses something of this vital human touch because it is compressed to a mere sketch. The balance, it is true, is redressed by a concluding section which stresses the underlying similarities of the main types of machinery and the effect upon them of the increasing concern of government with wage levels.

In the third study the part played by the trade unions in the determination of wages is brought out, the factors determining wages are indicated and some of the implications of the social redistribution of income and of a national wages policy are briefly reviewed. The latter part of this study covers such other subjects of negotiation as hours and overtime, demarcation of crafts, apprenticeship and the like. The fourth study, entitled "The General Staff of Labour", describes the work of the General Council of the Trades Union Congress, the evolution of a central trade union policy and the relations of the

trade union movement with the Labour party, with employers' organisations, the Government and, more briefly, with international bodies.

Valuable as are these studies in removing misconceptions regarding trade unions, the fifth study may prove to be the most important from that point of view. In this study of relations on the job, *Planning* gives a clear account of the position and functions of the shop steward that can scarcely fail to assist constructive thought on the whole question of organisation at the workshop level and the development of joint consultation, whether from the point of view of production or for other purposes. Moreover, the concluding section on psychological and other factors affecting relations indicates the importance of a number of the problems which the Panel on Human Factors of the Committee on Industrial Productivity is already examining.

For these factual studies, that Committee may well be grateful to Political and Economic Planning; but the last study, of trade unions in post-war Britain, which surveys trade unionism in relation to economic policy, full employment, nationalized industries and other major questions of the day is undoubtedly that which will have the widest appeal. This brilliant but sympathetic analysis should challenge constructive thinking within and without the unions, and indicates where the real psychological obstacles to high productivity and industrial democracy lie. For this study alone Political and Economic Planning has earned the thanks of all who are seeking the economic recovery of Britain, and no better approach could well be made to that essential task of education and the improvement of public relations than this concise and impartial assessment of opportunities, responsibilities and shortcomings.

CLINICAL ENDOCRINOLOGY

Clinical Endocrinology and Constitutional Medicine

By Dr. A. P. Cawadias. Pp. xii + 368 + 10 plates. (London: Frederick Muller, Ltd., 1947.) 42*s*. net.

THIS is an interesting and useful book. The author has made an extensive survey of the clinical conditions that can be attributed to malfunctioning of the endocrine organs, and has based his observations upon a reasoned picture of the "physiology and pathology of the neuro-endocrine systems". The introductory part of the book, which deals with this basic information, begins with a discussion of the concept of hormonal action and of the present trend for endocrinology to find its main links in the general field of metabolism. The rest of the introductory section is devoted to a general description of the "neuro-endocrine systems" of which the derivatives of the branchial pouches are part; of the neuro-metabolic systems based upon the gonads and the adrenals; and of those based upon the pituitary and pineal. By "system" Dr. Cawadias does not mean that a given endocrine substance is responsible for a series of changes that are part of a pattern of wider change which is influenced by the whole endocrine system. The term is used to emphasize the point that the endocrine organs work in a system with such neural structures as the hypothalamus, and that the latter in turn may be influenced by psychogenic factors. When he talks, for example, of the thyro-hormone system as being part of the neuro-endocrine system, he has in mind that cortical influences can affect the hypothalamus; the hypothalamus the anterior lobe of the pituitary; and the anterior lobe the thyroid; and that the whole thyroid system can be activated from any of these centres.

After its introductory section the book deals in turn with clinical disorders that relate to the thyroid, parathyroid and thymus group of glands; to those that relate to the gonadal adrenal group; to those of the pituitary pineal group; and to those of the pancreas liver group. The description of each disorder begins with a brief definition of the condition it discusses, and then surveys its etiology and physio-pathology, its signs and diagnosis, and its treatment.

The book is well written, and contains numerous interesting references to the older literature. References to recent advances in experimental endocrinology are, however, somewhat unnecessarily restricted. The illustrations are reproductions of drawings, and may not be to the taste of all readers.

NATURE CALENDAR

The Course of Nature

Through the Year from the Pages of *The Times*. Pp. 336. (London: Hodder and Stoughton, Ltd., 1948.) 10*s*. 6*d*. net.

"THROUGH the Year from the Pages of *The Times*" is the sub-title of "The Course of Nature" by W. Kay Robinson, well known as a sound field naturalist and an able writer, with a pen in the true Gilbert White tradition. He speaks of the changing seasons, the happenings of the passing days and reviews the pageant of the year in two weekly commentaries.

Beginning with "New Year Bird Songs" and the music of the great tit, "who seldom fails to ring his bell before this month is one week old", Mr. Robinson journeys interestingly onwards through the months to finish at Christmastide with the great tit once more trying his voice. On the way the author has much to write about; for example, one of his January notes deals with the "grey squirrel's New Year Celebrations". Commenting on the activity of the grey squirrel during the hardest of weather he goes on to say: "As one passes through the oakwoods one hears, first, a 'huff, huff, huff', followed by the queer sound which, beginning like a jay's harsh screeching, ends like a kitten's mew, and is possibly a love-call, possibly a challenge, or perhaps just means the squirrel is very much annoyed". The reviewer believes this cry to be a love-song, an idea supported by the date of birth of the young, many litters being born in February.

From squirrels to moles, from moles to waxwings, and then to redwings, flits the author's pen, commenting with regard to the last named on their inability to stand prolonged hard weather. "Though they come to us from colder regions to the north, the redwings seem constitutionally less fitted to withstand the rigours of winter than our own thrushes and blackbirds, and once the hedgerows have been stripped of berries they are in a bad way." But to appreciate this excellent survey of Nature through the seasons it must be read chapter by chapter, for it is full of good matter and that whether the month be January or June.

FRANCES PITT

Thomas Jefferson Among the Arts

An Essay in Early American Esthetics. By Eleanor Davidson Berman. Pp. xviii+305+20 plates. (New York: Philosophical Library, Inc., 1947.) 3.75 dollars.

IN view of the distinguished position occupied by the United States to-day, one is perhaps apt to forget what strife and labour went into the development of the young republic in the period of its third president. Those were times when 'art' was too expensive, yet in all its forms, so much to be desired. Thus we find Jefferson the revolutionary, workman, writer, thinker, toiling ever and anon to establish culture, both abstract and material, in his youthful America. To him there was no difference between 'pure' and 'applied' (whether art or science); all was for the benefit of mankind, and the pursuit of the good. Naturally, this led to some strong likes and dislikes, short shrift for Plato and Samuel Johnson, to mention but two.

Love of contrast is characteristic; formal Palladian architecture, surrounded by 'serpentine' gardens, as if to say "Oh Western Wind, blow soft and kind" upon the exceedingly solid and uncompromising stone buildings he admired and advocated. The author of the Declaration of Independence is entitled to such light and shade in his dealings with contemporary events.

The book itself is a careful document on the whole, somewhat disfigured by a fantastic misprint ("Nogarth" for Hogarth) on Plate 10, but pleasant to read and valuable for its references. It depicts Jefferson the man, very much a son of the *Enlightenment*, the master-craftsman of his age. F. I. G. RAWLINS

Magnetic Materials

By Dr. F. Brailsford. (Methuen's Monographs on Physical Subjects.) Pp. ix+156. (London: Methuen and Co., Ltd., 1948.) 6*s*. net.

THE appearance of this excellent monograph is opportune. During the past decade there have been immense advances in the quality of magnetic materials, both for cores of special transformers, electro-magnets, and particularly for permanent magnets, leading to greatly improved instruments, methods of measurement, and components generally. In one field alone, that of recording sounds on wire or powder, the whole process of magnetization had to be re-investigated, with a resulting new idea in the selection of material, leading to the sudden improvements which are about to be made commercial.

The author gives the clues to these reconsiderations, by relating the observed phenomena to defects in the shells of electrons and the rigidity or otherwise of the crystal lattice. Theory has indicated the lines of advance, and, in the laboratory, there are already 'better' (that is, better for special purposes) materials which are impracticable only by reason of cost.

The main purpose is, however, to give a complete story of the theory behind the materials, and this is offered with the utmost clarity. L. E. C. H.

Fahrten in Island

Von Rudolf Jonas. Pp. 198 + 83 plates. (Wien: L. W. Siedel und Sohn, 1948.) 3.50 dollars.

IN 1935 a party of Austrian scientists under Dr. R. Jonas and Prof. F. Nusser made a crossing of Vatnajökull, Iceland. The personnel was organised by the Austrian Students' Travel Association. The participation of the National Union of Students in England was proposed but could not be arranged in time. Some glaciological research was completed and part of the northern margin of the ice was mapped. This book is concerned mainly with that expedition and contains some good accounts of Icelandic scenery. The nunatak known as Mount Paul was rediscovered and fixed, and the crater of Sviagigur was explored. The numerous illustrations are excellent and the maps are adequate.

Cosmic Rays and Nuclear Physics

By Prof. L. Jánossy. (Frontiers of Science Series.) Pp. xiv + 186. (London: Pilot Press, Ltd., 1948.) 9*s*. 6*d*. net.

THIS is a more popular version of the book on cosmic rays by the same author which was reviewed in *Nature* of May 22, p. 785, 1948. The subjects treated, and their ordering, are much the same as in that book, though less detail is given. Theory is, in the main, omitted; but the most important formulæ are quoted, and a valiant effort is made to explain how they are derived. The book, like the earlier one, aims at comprehensiveness; but is not too well arranged.

The Frontiers of Science Series, of which the book forms part, aims at serving the non-specialist public who have outgrown the 'told to the children' approach. But this book can appeal only to a restricted public; for example, it introduces without explanation technical terms like azimuth, pentode, radius of curvature, electron volt, rest mass and energy, relativistic velocity, etc., and the fact that relativistic ideas are in principle explained later would scarcely compensate for the confusion which their first mention would evoke. The book could be read with profit by a man who has taken a science degree with physics as at least a subsidiary part, or by a brilliant schoolboy, and can be recommended to people like these. But it is not a popular book in anything like the usually accepted sense; it is a beginner's research manual, characterized by the researcher's inclusion of much detail, many references, and minor qualifications of general statements. It can be warmly recommended to people of the right sort; but one cannot agree that it achieves the avowed aim of the Series in that it "requires no previous specialized knowledge".

T. G. COWLING

Adventures with a Naturalist

By Roy Bedichek. Pp. 258. (London: Victor Gollancz, Ltd., 1948.) 12*s*. 6*d*. net.

THE scene of this book is in Texas, and its theme is the effect of the white man on animal and plant life. The author begins: "I have been looking over a two-hundred-acre plot of fenced land and trying to compare the life it now supports with that which it had been supporting for thousands of years when the first white man occupied it a hundred years ago". Although Mr. Roy Bedichek entitles his work, "Adventures with a Naturalist", although the title is excellent and he takes us on many delightful adventures observing a variety of birds, mammals and plants, we ever come back to the distressing effect of the white man, his agriculture and other activities, on the indigenous fauna and flora, an all too sad effect not limited to the American continent, but associated with him the world over. This is an interesting and pleasant book, despite its preoccupation with a mournful theme, and covers a wide field of Nature and country life.

FRANCES PITT

GENETICS OF CANCER

ONE of the many problems arising from the study of tumour transplantation and of chemical carcinogens is the variable degree of susceptibility to cancer shown by different animal strains. This phenomenon has focused attention upon the hereditary basis of cancer, and a great wealth of experimental data has now accrued. The aim of the recent symposium on the Genetics of Cancer held in London during June 24–25, and sponsored jointly by the Genetical Society of Great Britain and by the British Empire Cancer Campaign, was to survey this field and direct attention to the significance of such recent discoveries in genetics as, for example, the role of cytoplasmic particles in heredity, differentiation and disease.

The symposium could cover only certain selected groups of problems, and the papers presented centred around three main topics: (1) the inheritance of tumours in animals, (2) the genetical aspects of virus-induced and chemically induced tumours, and (3) the inheritance of cancer in man.

(1) The genetical basis of tumour transplantation in mice was discussed by Dr. P. A. Gorer (London), according to whom tumour-transplantability depends on a number of genes, some of which determine the production of specific antigens, identified as the 'histo-compatibility' antigens. The high rate of polymorphism observed in various strains of mice by serological analysis Dr. Gorer attributed to the high rate of mutation of these genes, a fact which would also explain the frequent failures of tumour transplantation.

The genetical basis of tumour production and that of its transmission may be quite different in complexity, as was shown by Dr. G. Hogreffe (Copenhagen). Transmission of leukæmia in the 'Aka' strain of mice seems to be due to a single Mendelian factor inherited as an autosomal dominant. From transplantation experiments, however, it became apparent that the genetical basis of tumour production is much more complex.

The genetical factors involved usually operate through various intermediate agencies such as hormones. When these intermediaries are analysed in isolation the primary biological factors of tumour production may be completely obscured, and this feature was well demonstrated by Dr. R. Korteweg (Amsterdam), who dealt with the influence of œstrogenic substances on tumour susceptibility. From his data it appears that the high incidence of mammary tumours in certain strains of mice is correlated with excessive secretion of œstrogens, and that at least part of the genetically determined disposition is caused by over-production of gonadotrophic hormone.

The complexity of the hereditary basis of tumour production was further emphasized by Dr. L. Dmochowski (Leeds), who analysed the interaction of mammary tumour-inducing 'milk-factor' and genetic constitution in the development of breast-tumours in certain high- and low-breast cancer strains of mice. Dr. Dmochowski arrived at the conclusion that there are two distinct sets of genetic factors, one controlling the susceptibility of breast tissue cells to the milk factor, the other controlling the propagation of the milk factor itself. The influence of hereditary factors on the production and transmission of the milk-agent was again made clear by Dr. W. E. Heston (Bethesda, U.S.A.), whose experiments have shown that the milk-agent is not itself active, but rather prepares the substrate, that is, the mammary glands, for the initiation and mediation of tumour production by genetic factors. Dr. Heston's analysis suggests that mammary tumours may be induced in the absence of the milk-agent through the provision or construction of certain genetic and environmental patterns.

(2) The alteration of the genetic structure of cells by chemical means is a subject of relatively late development in genetics, and throws light on the possible mechanisms underlying not only 'spontaneous' or naturally occurring mutations, but chemical carcinogenesis as well. Dr. M. Demerec (Cold Spring Harbor, U.S.A.) presented evidence that when *Drosophila* males were exposed to aerosols of seven carcinogens (four hydrocarbons, three azo-compounds) six such compounds were found to be mutagenic, while of nine non-carcinogens (five hydrocarbons, four azo-compounds) only two were mutagens. Somewhat similar results were obtained by Dr. J. G. Carr (London), and it would seem that specific chemical compounds can certainly induce permanent alteration in the hereditary structure of cells, whether germ-cells or somatic cells. Prof. L. C. Strong (Yale University) described a multiplicity of biological effects obtained by injection of methylcholanthrene into a series of mice over many generations. Some of these effects are definite point mutations, some are non-genetic, while others are possibly induced by inhibition of embryonic morphogenesis at critical periods.

Data were also obtained by Demerec, in experiments with aerosols of carcinogens on *Drosophila*, indicating that there is a semi-dominant gene which determines whether or not an individual will be sensitive to the chemical induction of genetic change. There is no doubt that experimental evidence of such a diversification of gene-controlled susceptibility to chemical effects is of the greatest significance in relation to the causation of cancer. The work of Dr. A. W. Greenwood (Edinburgh) on the inheritance of susceptibility and resistance to the virus-induced Rous sarcoma showed the existence of such genetically controlled differences in fowls.

The work of Sonneborn and others has established the existence of special cytoplasmic particles which also play a part in heredity. Prof. P. B. Medawar (Birmingham), through experiments on colour transformation in guinea pigs' skin, has provided what may be another example of the particulate basis of somatic cellular heredity, and has indicated that these determining particles can behave 'infectively' towards other cells. Dr. C. D. Darlington (London) further suggested that the origin of some types of cancer can be ascribed to mutation in such cytoplasmic determinants. By analysing the relationship between carcinogens and viruses and its bearing on the origin of cancer, Prof. A. Haddow (London) concluded that carcinogens may induce change in a cytoplasmic particle analogous with a virus, and that the change may be brought about directly or through a primary change induced in nuclear genes. In work carried out by Prof. R. D. Passey and his collaborators at Leeds, particles of 200–350 A. in diameter were identified by the electron microscope in the milk and tumours of high-cancer strain mice, and the biological test of these particles, for tumour-inducing activity, is awaited with special interest.

(3) In the session dealing with the inheritance of cancer in man, the symposium was presented with a general survey of the problem by Prof. T. Kemp (Copenhagen). The investigations carried out in Denmark suggest a genetical basis for predisposition to cancer, involving several genes, and furthermore that the localization, pathological features, rate of development and the time of onset of tumours may be similarly controlled. Since environmental factors also play a part in the development of particular kinds of cancer, any analysis of the heredity of cancer in man inevitably meets great difficulties. In order to compare the incidence of cancer in families with that in the total population, a critical collection of control material is required, and the difficulty of obtaining such material was stressed by several participants in the symposium. To a certain degree the problem has been solved by Prof. L. S. Penrose (London) and his collaborators, using the Registrar-General's statistics for calculating the expected proportion of breast cancer and cancer deaths among relatives dying at all ages and at most periods of the immediate past: the expected death- and incidence-rates for relatives can thus be compared with the observed figures. Prof. Penrose analysed the family-histories of 510 cases of mammary cancer by this method and found that the proportion of deaths due to mammary cancer in the patients' relatives was significantly increased, the rates for other types of malignancy remaining unchanged. Similar conclusions were arrived at by Prof. D. Smithers (London) from the study of family-histories of 459 patients with cancer of the breast. Prof. Penrose concluded that a specific genetical agent is responsible for mammary cancer in man. Evidence concerning the nature of this agent was obtained from studying incidence in paternal and maternal relatives, laterality, age of onset and history of breast feeding in the patient's own infancy, from which Prof. Penrose found some indication that the specific agent might be cytoplasmic but probably not transmitted through the milk.

The studies carried out by the Danish Cancer Registry on twins, under the direction of J. Clemmesen, were presented by Dr. Th. Busk (Copenhagen). From these it seems there is a greater tendency to higher incidence of cancer among partners of identical twins afflicted with cancer than among partners of fraternal twins with cancer, and also a clear tendency for tumours in identical pairs to affect corresponding organs in both partners, whereas this is not the case among fraternal twins. Though the investigation covered about 30,000 cancer patients, only 187 twins with cancer were found suitable for analysis.

It is hoped that the investigations reported at the symposium will direct attention to the importance of recording comprehensive family histories. The need for collaboration in these matters between physicians, geneticists and statisticians was illustrated in a paper by Dr. P. C. Koller (London), who presented two family-histories of xeroderma pigmentosum, one showing an unusually mild manifestation of the disease. The distribution of this condition among the two sexes and the unusual pathological features throw further light on its genetical basis and suggest that we may need to modify Haldane's concept of partial sex-linkage in respect of this particular disease.

The proceedings of the symposium will later be published in the *British Journal of Cancer*.

P. C. KOLLER

THE *Rh* FACTOR OF BLOOD

DURING the summer meeting of the British Medical Association in Cambridge, the pathological section held a discussion on "Recent Advances in our Knowledge of the *Rh* Factor". Only the opening speaker kept strictly to this title, the other two invited speakers reading papers on closely related topics; therefore each contribution will be described separately.

Prof. D. F. Cappell, of Glasgow, first briefly described the history of the discovery of the *Rh* factor. Landsteiner and Wiener, seeking to extend knowledge of the complexities of the agglutinogen *M* in man, immunized guinea pigs with the blood of rhesus monkeys. Surprisingly, they found that the resulting anti-rhesus serum agglutinated 85 per cent of human bloods and that the agglutinogen '*Rh*' so defined was unconnected with *M*. Almost immediately afterwards Wiener and Peters demonstrated the clinical importance of this antigen by showing that, in each of four cases where repeated blood transfusions had been followed by hæmolytic reactions, the cause lay in the sensitization of the patient to the *Rh* antigen. Levine and his co-workers then showed that the dreaded intra-group transfusions of women in the puerperium were also the result of iso-immunization to *Rh*, and they directed attention to the almost invariable association of such reactions with death of the fœtus or the occurrence of icterus gravis neonatorum. They produced striking statistical evidence that in these cases the *Rh* negative mother became sensitized during pregnancy to the *Rh* antigen in the blood of her fœtus and formed *Rh* antibodies.

Prof. Cappell suggested that the term *Rh* factor should be reserved for the antigenic component common to man and the rhesus monkey, and the term *Rh* blood group should be used to include the whole complex of antigens which had been shown to occur together in different combinations in man. Prof. Cappell now turned to the work of Prof. R. A. Fisher and emphasized that it was he who had first recognized the pattern behind the complex reactions within the *Rh* groups. Fisher first noted that the reactions of different bloods with two of the four *Rh* sera then discovered were antithetical, and he postulated that the alternative reactions were due to the presence of an antigen *C* in some bloods and of an allelomorph *c* in others. Fisher postulated the existence of two other pairs of allelomorphic antigens, *D* and *d* and *E* and *e*, which determined positive or negative reactions with the two other kinds of sera then known, which he called anti-*D* and anti-*E*. He predicted the discovery of two further antibodies, anti-*d* and anti-*e*, and the correctness of his entire conception was soon demonstrated when these predictions were fulfilled. Fisher's original scheme had had to be extended since Race's discovery of further allelomorphs C^w, C^u and c^v at the *C*/*c* locus and Stratton's discovery, recently extended by Race, of further allelomorphs at the *D* locus.

Prof. Cappell emphasized the importance of a pure anti-*D* serum for classifying bloods as *Rh* positive or negative. For clinical purposes the important thing was whether a person was *D* positive or negative, for all *D* negative persons could form anti-*D*, and sensitization to *D* was far commoner than sensitization to the other *Rh* antigens. Thus, a person of type *Cde*/*cde* might at one time have been considered *Rh* positive because of the possession of *C*;

but such a person was just as liable as one of type *cde/cde* to form anti-*D* and should be considered as *Rh* negative.

Iso-immunization of an *Rh* negative mother rarely occurred to a sufficient extent during a first pregnancy to produce hæmolytic disease of the newborn, but the second or subsequent *Rh* positive offspring might be affected. Prof. Cappell had found that the earlier hæmolytic disease occurred in a family, the severer was its form; he interpreted this as indicating a notably greater susceptibility to immunization on the part of some women. One remarkable fact that was now fully established, but the cause of which remained debatable, was the protection against hæmolytic disease afforded by *ABO* group differences between mother and fœtus. Thus, whereas in Scotland in a random sample more belonged to group *O* than to group *A*, in a series of 56 *Rh* negative Scottish women who had formed *Rh* antibodies, it was found that 28 belonged to group *A* and only 18 to group *O*.

Turning finally to the treatment of hæmolytic disease, Prof. Cappell said that one controversial question was whether nervous sequelæ could be prevented by early transfusion of *Rh* negative blood. In his own series of thirty infants treated by transfusion of *Rh* negative blood immediately after birth or within the following twelve hours, all developed normally, both mentally and physically. By contrast, in a series treated in Glasgow between 1934 and 1944, mainly by transfusion of blood of unselected *Rh* type, about 12 per cent showed some residual nervous sequelæ. He was doubtful whether the cerebral damage which results in nuclear jaundice occurred before birth; he suggested that anoxia in the immediate post-natal period, due to difficulty in establishing respiration, might be the cause.

Dr. P. L. Mollison confined his remarks to the diagnosis and treatment of hæmolytic disease of the newborn. At the Medical Research Council's Blood Transfusion Research Unit, Miss M. Cutbush and he had, during the past eighteen months, examined fifty *Rh* positive infants born to mothers whose sera contained *Rh* antibodies. In every case the infant's erythrocytes could be shown, by the direct Coombs' test, to have antibody adsorbed on to their surface. Only three of the fifty infants failed to develop anæmia. Since some infants with a positive direct Coombs' test never developed signs of a hæmolytic anæmia and since others only developed mild signs which did not require treatment, it was necessary to try to form an estimate of the severity of each case. This was best done by examining cord blood. Among the infants with hæmolytic disease whose cord blood they had examined, about two-thirds had a hæmoglobin value below the normal range, that is, less than 15 gm. per cent; almost all had a bilirubin concentration of more than 3·0 mgm. per cent and about three-quarters showed more than 10 nucleated R.B.C. per 100 W.B.C. in the peripheral blood. These three signs of anæmia, hyperbilirubinæmia and erythroblastæmia were fairly well correlated if cord blood was examined and, taken in conjunction with other findings, enabled one to assess the degree of affection.

Dr. Mollison pointed out that hæmolytic disease killed infants at two main stages and the mechanisms were probably separate. Deaths *in utero* or within twelve hours of birth seemed always to be associated with severe anæmia; these infants might display a syndrome similar to that developed by adults with chronic severe anæmia and described by Sharpey-Schafer as the "hyperkinetic phase"; its chief features were: a raised cardiac output, a high pulse-rate and pulse pressure, a high venous pressure and œdema. They had found that a raised venous pressure was a striking feature in severely anæmic infants born alive. The second group of deaths occurred at two to four days; in these cases the infant was profoundly jaundiced and at autopsy kernicterus was a frequent finding. At present the most rational method available for trying to prevent deaths from both of these causes was premature termination of pregnancy followed by an exchange transfusion with *Rh* negative blood.

Exchange transfusion had become a relatively simple procedure since the introduction by Dr. L. K. Diamond of the technique of passing a fine transparent plastic catheter up the umbilical vein; the infant's blood was then withdrawn and replaced by *Rh* negative blood in successive stages. It was an advantage to use a slightly concentrated suspension of erythrocytes so as to leave the infant with a count of approximately 5,000,000 *Rh* negative erythrocytes per c.mm. by the end of the exchange transfusion. It was seldom necessary to have to carry out any further treatment.

Dr. Mollison stated that the overall mortality in the small series he had referred to was 28 per cent. He considered it impossible to make any worth-while comparisons with other series and mentioned the following difficulties: the small size of this and of most other series; recent changes in the diagnostic criteria of the disease; the different prognosis of different forms of the disease and the consequent important effects of selection of cases. As an example he quoted some of their own findings. The first affected infant in a family had a 92 per cent chance of recovery if its mother had never received a transfusion of *Rh* positive blood; but if she had been transfused and was thus more highly sensitized, the infant's chance of survival was only 50 per cent. An undue proportion of transfused mothers in a series of cases would thus greatly increase the mortality. He considered that exchange transfusion should be given a widespread trial because it was a rational treatment and because in practice it had proved to be the most simple and satisfactory method available.

Dr. R. R. A. Coombs described work carried out in the Department of Pathology at Cambridge which had established the occurrence of hæmolytic disease in newborn thoroughbred foals; this disease, like the human one, was due to iso-immunization of the mother during pregnancy against a blood group antigen present in the erythrocytes of her offspring. This work followed on that of Caroli and Bessis, who last year had shown that the icterus of newborn mules was also due to iso-immunization during pregnancy.

Dr. Coombs emphasized that the present investigation had been undertaken by a team. The clinical studies were made by Mr. Parry, scientific officer of the Animal Health Trust, and Messrs. Day and Crowhurst, veterinary surgeons at Newmarket; the hæmatological examinations had been made by Dr. Hoogstraten; the morbid histology had been studied by Dr. Hinde and the serology by Dr. Heard and himself.

Clinically, the foals were normal at birth; thereafter at periods varying from a few hours to five days, they showed progressive weakness, icterus and pallor, accompanied in acute cases by hæmoglobinuria.

The serological investigations had been greatly complicated by a lack of knowledge of the blood groups of horses and by difficulty in obtaining blood samples from the sires of the affected foals. However, they had tested the sera of all the mares, the offspring of which were affected, against the red cells of other mares and of various other available horses. They had found that most of the sera contained high titre saline agglutinins acting on various other horse bloods and all contained blocking antibodies, revealed by the indirect antiglobulin sensitization test. None of the control sera contained more than traces of iso-antibodies.

As in the human disease, the direct anti-globulin sensitization test had proved extremely valuable in making a rapid diagnosis. Hæmolytic disease in newborn foals had to be differentiated from bacterial septicæmia which might also cause jaundice. They had tested six cases of hæmolytic disease, all of which had given strongly positive tests, and two cases of septicæmia, both of which had given negative tests. The reagent they had used was a rabbit anti-horse globulin serum.

The hæmatological picture was one of profound anæmia, with hæmoglobin levels of only 3–4 gm. per 100 ml. Nevertheless, very few reticulocytes and no erythroblasts were seen in the peripheral blood.

One of the most interesting features of the morbid histology was an extension of tubular epithelium into the glomeruli in three cases which had shown hæmoglobinuria; similar changes had been observed in 'traumatic anuria' in man.

Finally, Dr. Coombs mentioned some work which Dr. Heard is conducting. This is an attempt to produce hæmolytic disease in rabbits. There was every reason for hoping that this work would be successful and there was no need to stress the advantage that would result from having a laboratory animal in which the disease could be produced at will. Many problems of hæmolytic disease could only be investigated by experiment and could therefore never be tackled directly in man. P. L. MOLLISON

GENETICAL STRUCTURE OF PLANT POPULATIONS

A SYMPOSIUM on the "Genetical Structure of Plant Populations" was held at the Brighton meeting of the British Association for the Advancement of Science, on September 13, in Section K (Botany), with Col. F. C. Stern in the chair. Dr. W. B. Turrill (Kew), in an opening paper, defined a population, as the term should be used in biology, as the sum total of individuals of a stated kind, in a stated area, at a stated time. The need of careful determination of 'kind' and the desirability of preserving proper voucher specimens where there is the slightest possibility of determinations being called in question were emphasized. The extensive and intensive studies now being completed on numerous populations of a limited number of species of seed-bearing plants of the European flora have revealed an unexpected wealth of variation in structure and behaviour. At Kew and Potterne, investigations combining the methods of modern taxonomy, cytogenetics and ecology are throwing much light upon the make-up of species as population complexes. Attention was directed to the bladder campions (*Silene maritima* and allied species). In these some variations are common, as degrees of indumentum in *S. cucubalus*, others are rare, as long cylindrical calyx in *S. maritima*. Some characters have obvious survival value for definite ecological habitats, such as habit differences between different species or varieties. Spasmodically occurring mutations may be lethal or harmful in various degrees, like 'poor petal' or 'split calyx', whereas other variations appear to be neutral at least in some environments. Some variants have a wide geographical range while others are restricted to very local habitats. Hybridization experiments on a very extensive scale have shown genetic differences for most of the variations; but whereas some characters have a simple genetic basis others can only be explained by the interaction of several genes. Long-isolated populations of relatively small size (as some inland populations of *S. maritima*) may show much less variation than is normally found in more widely spread populations. Parallelism between sea-coast and high-mountain populations of different species is very striking.

Mr. J. L. Crosby (Durham) dealt with intra-population heterogeneity and the breeding range of the individual plant. In the primrose (*Primula vulgaris*), in addition to reciprocally outcrossing plants with 'pin' and 'thrum' flowers, there are, in certain populations in Somerset and the Chilterns, plants with 'long homostylous' flowers which are normally self-fertilized and outcross on to pins. Observation agrees with theoretical conclusions that 'homostyles' are increasing to about 80 per cent, 'pins' are decreasing to about 20 per cent, and 'thrums' are entirely disappearing. Slow at first, change later becomes quite rapid. Considerable heterogeneity between different parts of any one such population may exist. A few yards only may separate groups with constitutions so different that they represent evolutionary stages many generations apart. Such large differences cannot have arisen in one generation by chance from a homogeneous population but must have been initiated at an early stage. One section of the population reached the stage of more rapid change and the difference then became amplified. The change could not, however, even be maintained with free distribution of pollen between the divergent groups, even though 'homostyles' are self-pollinated. The breeding range of the individual primrose must be of the order of a few yards only, and a single population cannot be considered as a continuous interbreeding unit.

Dr. A. J. Bateman (John Innes Institution) considered populations of cultivated plants. He pointed out that the breeding system of the species is of paramount importance in determining the genetical structure of a population. The total range of breeding systems is from complete self-fertilization as in barley to complete cross-fertilization as in cabbage. Subordinated to the breeding system are selection intensity, population size, and gene dispersal. Heritable variation would be at a minimum in a pure line; but varieties of self-fertilizing crops are rarely represented by pure lines. The different causes of variation within varieties which should be pure lines are: (*a*) residual hybridity of the original variety; (*b*) mutation and structural change; (*c*) seed admixture; (*d*) cross-pollination. Cultivated plants show a continuous range in breeding systems from self-incompatibility and dioecism giving full outbreeding, to regular self-pollination and vegetative reproduction, giving full inbreeding or its equivalent.

Experiments with rye indicate that thirty-six plants can maintain a variety in its original form; but six plants are too few to avoid inbreeding depression and undesirable loss of variability in cross-breeding crops. Cultivated plants are selected for a special environment. When human selection is relaxed the subsequent deterioration shows us how natural populations with similar breeding systems will respond to changes of environment. A study of the dispersal of pollen of cultivated plants shows that inter-crossing is mainly confined to immediate neighbours, though finite amounts of crossing occur up to large distances. The part which this dispersal plays in determining population structure again depends on the breeding system.

Dr. H. G. Baker gave an account of gene-flow between inter-fertile species. In 'pauciform' hybrids, the individuals are without fertility and cannot be back-crossed to their parents or form segregating swarms by selfing. Other hybrids, termed 'multiform', are sufficiently fertile to perform either of, or both, these acts. Yet in 'multiform' hybrids gene-flow is often restricted or even absent. In the sub-tribe Madiinæ of Compositæ, lack of internal harmony within the plant may lead to certain 'recombination types' failing to endure serious competition. Self-pollination reduces frequency of hybrids, as do also cleistogamy as in *Viola* and apomixis as in *Poa*. Certation effects favouring pollen-tubes of the same species as the styles also reduce interspecific hybrids as in *Melandrium*. Interspecific hybridization is more likely to occur where one or both species is under- rather than over-dispersed. Matrocliny may increase the possibility of gene-flow. Linkage hinders gene-recombination and may be of importance in preserving the parental types in natural populations. 'Variance of fertility' is sometimes seasonal. Internally determined restrictions on gene-flow are no less important than those imposed by the external environment. Some hybrid swarms develop under man's influence; others do not. When two kinds of plants come to occupy adjacent habitats, the exchange may occur of genes resulting in characters which are neutral so far as the ecological distinction between the kinds is concerned. With modification of the environment, characters excluded previously on ecological grounds may occur.

Dr. D. H. Valentine described interspecific hybridization between primrose (*Primula vulgaris*) and oxlip (*P. elatior*) in woods in certain regions of East Anglia. The populations of individual woods are isolated from one another. Some woods contain one or other of the pure species, others contain the two species and their hybrids. Where the species meet, they occupy distinct areas in the wood, probably because of their different ecological preferences. Hybrids are always frequent, but they do not outnumber the pure species. From reciprocal artificial crosses, a low yield of viable seeds is obtained, and the vigour of the F_1 hybrids is variable. A somewhat better yield of seed is obtained when the F_1 hybrid is selfed or backcrossed. There are thus both ecological and genetical barriers which tend to prevent fusion of the species. The condition appears to be one of equilibrium, which may shift in one direction or the other as variations of local climate and other environmental factors occur. Efficient barriers of more than one kind separate oxlip and cowslip (*P. veris*), and the hybrid between primrose and cowslip, which is partially fertile, is of widespread occurrence; but extensive hybrid populations are apparently rare, perhaps because of the marked ecological differences between the species.

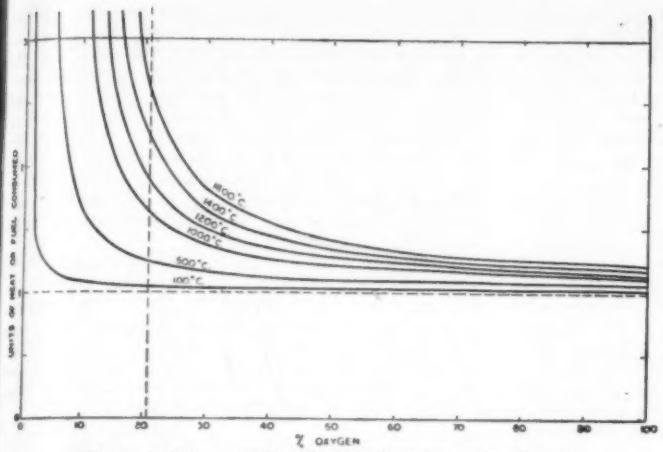
In the discussion following the five papers, Dr. J. M. Rasmusson commented upon the successful attempt to combine the points of view of wild and cultivated plants, of the botanist and the plant-breeder. In sugar-beet it had been found that from five to ten plants were too few and forty to sixty plants enough to prevent inbreeding depression. A distance of 200 yards prevents crossing in the open in sugar-beet. Dr. C. D. Darlington questioned Mr. Crosby's explanation of the spread of homostylous plants in his primrose populations. Prof. J. G. Nannfeldt urged that the experimental methods of genetics and ecology should be increasingly applied to the native flora. Captain C. D. Diver noted that while there were considerable differences in breeding mechanisms between animals and plants, results were often similar. Mr. A. J. Wilmott asked that more investigation should be undertaken on chances of cross-pollination by wind with increasing distance. Mr. O. H. Frankel maintained that seed merchants in Great Britain aimed for saleability (largely a matter of uniformity), not quality (productivity).

APPLICATION OF OXYGEN TO STEEL-MAKING

By Dr. W. C. NEWELL
British Iron and Steel Research Association

MANY modern technical developments have been made by preparing materials of greater suitability for specific purposes from the naturally occurring materials which were employed earlier. An obvious example of this is seen in the superior materials now used for building construction and a comparison with natural clay which is still used in some places. Though air has, wittingly or unwittingly, been used for combustion from very early times, the bulk manipulation of gases on a commercial scale is such a modern development that the commercial use of oxygen for combustion is only now just becoming possible. The use of an oxygen-enriched air blast does not appreciably increase the heat of combustion, but it does reduce the cooling effect of the nitrogen present in air which is normally passed through furnaces. The magnitude of this effect is appreciated when it is pointed out that during the combustion of carbon to the dioxide with ordinary air, the weight of nitrogen involved is nearly ten times the weight of the carbon. Under certain conditions thermal recuperation or regeneration of the heat from the gases leaving the furnace is possible, but at high temperatures this is inefficient and costly.

The magnitude of the loss of sensible heat with the nitrogen passing off from furnaces is greater the higher the temperature, and for steel-making temperatures, of say up to 1,700° C., it becomes of such major importance that many attempts have been made in various parts of the world to employ oxygen-enrichment to improve the thermal efficiency of steel-making processes. Recently[1] full technical details have been published of the way in which oxygen-enrichment is being successfully applied on a continuous production basis at Messrs. Cattons' steel foundry in Leeds. The accompanying chart shows for the combustion of carbon to dioxide the number of



Effect upon fuel consumption of emergent gas temperature for the reaction: $C + O_2 \rightarrow CO_2$

units of fuel consumed for varying percentages of oxygen used in the blast of the furnace, the heat units consumed above one unit being those wasted as sensible heat with the emergent nitrogen. From this chart it will be seen that, for emergent gas temperatures below 1,000° C., little thermal gain can be effected by the use of oxygen enrichment, but that the gain increases rapidly for higher temperatures. Further, it is seen that there is little thermal advantage to be gained by raising the oxygen content of the blast beyond about 40 per cent.

A steel foundry requires molten steel to be supplied intermittently and at a higher temperature than for the production of steel ingots, and at these trials at Leeds, by using 30 per cent oxygen in the blast (as compared with normal approximately 20 per cent in air), it has been found possible to obtain molten steel 50° C. hotter with a simultaneous economy in costly ferro-silicon, which is normally employed as a fuel of high calorific value. Alternatively, advantage has been taken of this gain in thermal efficiency by adding cold steel scrap or ferro-alloys to the steel after the blowing operation. Thus substantial economies have been shown to be practicable, and the way has been opened up for the use of the side-blown Bessemer converter for the production of more highly alloyed steel. Moreover, it has been shown that the use of molten steel of higher temperature does not necessarily mean that there will be any greater attack upon the refractory material of the converter lining or upon the sand of moulds into which the steel is cast; indeed, the penetration of liquid steel between the sand grains has been less than usual, and the surface finish of the castings has been better.

The most striking result of the use of oxygen enrichment is that the flame issuing from the converter is far brighter than usual and the steel is made in about half the usual time. This is a reminder of those early experiments of Priestly which are repeated to this day in school laboratories to demonstrate the enhanced rate of combustion of a wooden splint in oxygen. Normally, during the early stages of blowing a side-blown Bessemer converter, silicon is being oxidized and there is very little flame; and the flame later is associated with the combustion of carbon monoxide at the mouth of the vessel. Using oxygen enrichment and a very low silicon content in the molten metal, the flame is observed right from the commencement of the blowing operation; but it is interesting to note that in spite of the fact that under these conditions the flame is of far greater intensity the agitation of the metal within the vessel appears to be less, as judged by the lower loss of ejected metal. In fact, with higher oxygen contents in the blast there are distinct indications that the metal is not agitated enough to ensure uniform oxidation. These observations are leading to trials of modifications in the design of the vessel, and especially the tuyeres, which may lead to greater efficiency of operation and to the extension of this process of steel-making for bulk ingot steel production.

The industry concerned with the large-scale production of oxygen is making great efforts to keep pace with the rapidly increasing demand; but some idea of the magnitude of the problem is gained when it is pointed out that in the steel foundry referred to about 1,500 cubic feet of oxygen are consumed per ton of steel made, this volume of oxygen weighing about one hundredweight.

At the present time, large consumers of oxygen are supplied with liquid oxygen, which though costing more to produce than oxygen supplied in gaseous form, is much cheaper to transport. However, at the works referred to, about eight tons of oxygen are consumed per week, and this makes necessary a regular shuttle service of lorries carrying liquid oxygen. Thus it appears that the magnitude of the demand is going beyond the economic limit for the supply in liquid form, and extensive plans are being made for the supply of oxygen by some form of gas pipe line to those parts of Britain where the demand for oxygen for such purposes is likely to be great. At the present moment, the high cost of oxygen supplied in liquid form is likely to restrict extensive application of the process to steel foundries where greater advantage can be taken of the technical improvements brought about by oxygen enrichment.

[1] Harrison, J. L., Newell, W. C., and Hartley, A., *J. Iron and Steel Inst.*, 281 (July 1948).

OBITUARIES

Prof. S. W. J. Smith, F.R.S.

Samuel Walter Johnson Smith, formerly Poynting professor of physics in the University of Birmingham, died on August 20 in his seventy-eighth year. His death will be deeply regretted by many former students of the Royal College of Science, London, and of the University of Birmingham, who will remember him gratefully both as a teacher and as a friend.

The son of a well-known railway engineer, Smith was born in Scotland in 1871 and went first to school in Tayport and Dundee, completing his early education at Rutherford College, Newcastle-upon-Tyne. In 1887 he entered the Royal College of Science with a

national scholarship, and after completing the course there went to Trinity College, Cambridge, in 1891 with a major scholarship. He obtained a first in Part 1 of the Natural Science Tripos in 1892 and in Part 2 he had the rare distinction for those days of obtaining a double first, in physics and chemistry. Afterwards he was appointed Coutts-Trotter Student and worked in the Cavendish Laboratory under Sir J. J. Thomson until 1896.

Upon leaving Cambridge, Smith returned to the Royal College of Science, London, as senior demonstrator in physics and became assistant professor in 1912. He obtained the D.Sc. degree of London in 1908 and was elected a fellow of the Royal Society in 1914. During this period at South Kensington, he took a prominent part in the work of the Physical Society of London, being honorary secretary from 1908 until 1916 and vice-president during 1916–19. In addition to his heavy secretarial and teaching work, he did a great deal of research in this phase of his career and it was probably his most fruitful period.

In 1919 he succeeded Poynting as professor of physics at Birmingham and undertook the difficult task of coping with the many problems arising from the First World War, particularly those resulting from a great increase in the number of students. Somewhat later, about 1924, he organised a new honours course in physics, as up to that time only a general degree had been awarded. He was dean of the Faculty of Science from 1929 until 1932. In 1936 he retired and was appointed emeritus professor, and from that time until his death he lived a quiet and somewhat secluded life.

In his researches, Smith devoted himself almost exclusively to two fields of work. His first investigation arose quite naturally from his training in both physics and chemistry; he selected it himself and worked at it in the Cavendish with very little guidance. It dealt with the contact difference of potential arising at a mercury – electrolyte interface, and necessitated a great deal of careful observation using various types of capillary electrometer; the conclusions were published in the *Phil. Trans. Roy. Soc.* of 1899. Later, at South Kensington, with the assistance of collaborators, he extended and amplified this work, turning to problems of electrolytic resistance and ionic migration. The results of these experiments were published in a series of papers in the *Phil. Mag.* and the *Proceedings of the Physical Society*.

The second and perhaps the more important field of Smith's work started from a problem in ferromagnetism suggested to him at South Kensington by Sir Arthur Rücker, who surmised that an examination of the magnetic properties of meteoric iron might throw some light upon the cause of terrestrial magnetism. It soon became clear, however, that this was no problem in terrestrial magnetism but rather a problem from the domain common to geology, metallurgy and physics. The meteoric irons are, in fact, examples of iron – nickel alloys which have cooled with extraordinary slowness and show structural characteristics not reproducible by artificial means. Smith worked alone on this question for a number of years, using a method of investigation simple in principle but requiring great skill and care in execution. He published the results of his observations in an important memoir appearing in the *Phil. Trans. Roy. Soc.* for 1908.

This work was continued at Birmingham where, in addition to extensions of the magnetic technique, metallographic and X-ray methods were called into service. During these years a great deal of assistance was given by the late James Young, who published a number of papers dealing with the results of the X-ray examination of some of these meteoric specimens. The magnetic and metallographic work was carried out under Smith's direction, and there exists a great deal of unpublished material. It is probable that towards the end of his life Smith was searching for some far-reaching synthesis of the observations which he failed to discover. In March 1939 he published in *Nature* a very brief summary of the work and of his tentative conclusions.

Smith was a man of great personal charm with a manner at once disarming and dignified. Over many younger men he exercised a special fascination, arising from a genuine gift of sympathy and also from the interest of his conversation. As a teacher he was held in the highest esteem throughout his life. In 1900 he married Dorothy Muriel Stamp who, together with an only daughter, survives him.

M. L. Oliphant
A. A. Dee

King Ferdinand of Bulgaria

Ex-King Ferdinand of Bulgaria, who died recently at Coburg at the age of eighty-seven, was born a prince of Saxe-Coburg Gotha. From early youth he had a passion for natural history; but he was no mere amateur, and his studies of botany, entomology and ornithology were serious and scientific. Of the three, his chief interest lay in ornithology, and he first made his appearance among ornithologists at the age of thirteen, under the guidance of Crown Prince Rudolf of Austria, himself an ornithologist of repute. In 1887 Prince Ferdinand joined the Deutsche Ornithologische Gesellschaft, of which Society he remained patron until his death; in later years he was elected an honorary member of the Royal Hungarian Institute of Ornithology and also of the British Ornithologists' Union. In 1879 he made an official visit to Brazil the opportunity for studying the bird-life of South America, and on becoming Tsar of Bulgaria he gave every encouragement to the study of the ornithology of the Balkans and the collection of specimens. The museums and zoological gardens of Sofia are further and concrete evidence of his active interest.

After his abdication, he retired to Coburg, where he devoted most of his time to his private museum and large collection of living birds, though he frequently visited his castle in the Carpathians. The aviaries at Coburg contained more than eight hundred specimens, including many rare species, most of which had been collected by King Ferdinand himself, and he knew where each one had been obtained or purchased. He would spend hours in his aviaries studying the habits of the birds. A section of the gardens was set aside for wild-flowers which the King had either collected himself or had had given to him, from every part of the world; and, as with the birds, he knew the history of each plant.

In 1927–28 King Ferdinand made a collecting trip to South America and described his experiences in his book "Der Kŏnig reisst". In 1929 he made an expedition, accompanied by his niece, Princess Victoria, Countess of Solms-Rödelheim, a keen botanist, and his museum curator, Dr. Hans von Boetticher, to Victoria Nyanza and the mountains of equatorial Africa. His account of the expedition,

with a report on the ornithological observations, compiled by Dr. von Boetticher, was published as a special supplement of the *Journal für Ornithologie* in 1930. He was a regular attendant of the meetings of the Deutsche Ornithologische Gesellschaft which were held each year in various parts of Germany and took part in all the ornithological excursions, however arduous. In 1934 he attended the International Ornithological Congress at Oxford, including the visit to the bird islands off the Pembrokeshire coast. His enthusiasm and activity were such that even at the age of seventy-six, in 1937, he was considering the possibility of a trip by aeroplane and motor-car from Cairo to the Cape in order to study the bird-life throughout Africa.

He was a brilliant linguist, and in fact it was difficult to discover how many languages he did know, for he would turn with bewildering speed and facility from French, German, English, Bulgarian to Portuguese. His dominating personality, astuteness as a politician and the unpopular role he took in the destinies of Europe have always been emphasized; but his love of beautiful things, his great generosity to the cause of science and to his friends, his delightful sense of humour and a surprising simplicity are sides of his character which have generally been missed.

PHYLLIS BARCLAY-SMITH

WE regret to announce the following deaths:

Peter A. Bungart, for nearly twenty-five years associated with the Department of Geology and Palæontology of the Cleveland Museum of Natural History, who was a distinguished collector and preparator of fossil fish, on July 30, aged seventy-two.

Prof. Alexandr Orlov, professor of petrography and chemical mineralogy at the Charles University of Prague, known for work on the origin and occurrence of groups of ore-bearing rocks and soils, the metamorphosis of limestones and dolomites and especially for his petrographic studies of Czech garnet deposits, aged forty-nine.

Prof. D. A. Welsh, emeritus professor of pathology in the University of Sydney, where he held the chair from 1902 until 1936, on May 13, aged eighty-two.

NEWS and VIEWS

Botany at Cambridge:
Prof. F. T. Brooks, C.B.E., F.R.S.

ON September 30 Prof. F. T. Brooks retired from the professorship of botany in the University of Cambridge, which he has held since 1936. When he succeeded Sir Albert Seward he became head of a large and well-organised department, which continued to expand and prosper under his direction in spite of the difficulties and restrictions of the war years. At the present time, accommodation in the Botany School is strained to its utmost by ever-increasing numbers of research students, and investigations are being made in all the main fields of botanical science, while the number of undergraduate students is well maintained. During his tenure of the chair, Prof. Brooks has continued his researches in plant pathology, and during his career he has been responsible for the training of a large number of mycologists and plant pathologists who now hold important posts in many parts of the world. His wise guidance and administrative ability have been freely extended to the University Botanic Garden; he has acted as chairman of its executive committee and as secretary of the managers of the Cory Trust. His work has extended beyond the University; he was for five years an active member of the Agricultural Research Council and has been one of the general secretaries of the British Association for the Advancement of Science. He will continue to live in Cambridge and to carry on his researches in the Botany School.

Prof. G. E. Briggs, F.R.S.

PROF. G. E. BRIGGS will succeed Prof. Brooks as professor of botany. He will be the ninth holder of the chair, which was founded in 1724, and the first plant physiologist to be appointed to it. His researches on photosynthesis and growth have brought him a world-wide reputation as a clever experimenter and a critical and original thinker. A pupil of F. F. Blackman, he has been head of the Sub-department of Plant Physiology in the Botany School since 1937, and was raised to the rank of professor in 1946. He is a man of wide interests, distinguished as a teacher, and he has had considerable administrative experience in the University and as a fellow and officer of St. John's College.

Solar Eclipse of November 1: British Expedition to Mombasa

A SMALL expedition from the Royal Observatory, Greenwich, under Dr. R. d'E. Atkinson, is proceeding to Mombasa to observe the eclipse of the sun on November 1; the purpose is to try out a method of correcting the moon's place from observations on the thin crescent of the sun seen from a station where the eclipse just fails to be total. Measurements of the position-angle of the line of cusps, as a function of the time, can give corrections to the differential co-ordinates of sun and moon which are independent of any assumption about their apparent radii, and independent also of irradiation if the sky is uniform. If a large number of such measures is made, the effects of irregularities of the moon's limb also cancel out to a considerable extent. In the neighbourhood of Mombasa, where the eclipse is nearly 98 per cent total, the position-angle swings round through about 70° in 2¼ minutes; it is hoped to obtain 3,000 timed pictures on 35-mm. film in this interval. The camera will be stationary, and the trail of successive images produced by the sun's diurnal motion will give the zero of position-angles. An ordinary small visual telescope-lens, stopped down to about $f/40$, is being used, in conjunction with a green filter and exposure times of 1/1,000 sec. Special time-signals will be sent from Rugby, and these will be recorded, together with the instants of the shutter-openings, on tape-chronographs which have been made at Abinger. The accuracy of the results will be limited by uncertainties about the contour of the moon's limb;

it seems certain that if the limb were smooth the moon's place would be determined with considerably greater accuracy than that with which it is at present computed in the Nautical Almanac. Whatever the limb-effects may be, the accuracy should be higher than that which results from six thousand ordinary occultations, since the timing is considerably better than is possible with visual methods, while all effects due to personality, systematic time-differences between stations, and real changes of libration are eliminated. If the method works out as well as is hoped, it will probably be used for long-range geodetic purposes; the accuracy will then be more severely limited by our ignorance of the moon's limb, since considerable changes in the libration are inseparable from a long shadow-path. However, the accuracy should still be considerably greater than can be obtained, for the same purpose, by merely timing the instants of contact, since in that case all the emphasis is on some one point of the limb at each contact; a chance error at that point can cause a large error in the time.

Frozen Foods Consultative Group

To ensure the fullest co-operation and collaboration between the various research organisations engaged in the field of food, and also that inquirers will be directed to the best sources of information, the Frozen Foods Consultative Group was set up last year. It consists of representatives of research organisations, official and semi-official, under the chairmanship of the director of food investigation, Dr. Franklin Kidd. The objects of the Group are in the main the exchange of information on research investigations in progress on the preservation of food by quick-freezing processes so as to prevent overlapping and to discover gaps in research programmes. The terms of reference are: (*a*) to table and discuss the results of investigations into new developments in methods of preserving food by freezing; (*b*) to consider the planning of further investigations (each organisation to retain its own independence and the responsibility for its own programme); (*c*) to maintain contact between investigators in such fields as packaging and engineering which bear on preservation by freezing; (*d*) to direct inquirers in industry to the best sources of information. The following research organisations and stations are represented: Low Temperature Research Station, Torry Research Station and Ditton Laboratory (all of the Department of Scientific and Industrial Research); Scientific Adviser's Division, Ministry of Food; British Food Manufacturing Industries Research Association; Printing, Packaging and Allied Trades Research Association; British Baking Industries Research Association; Fruit and Vegetable Preservation Research Station, Chipping Campden. The Group has power to invite to its meetings representatives of other organisations such as the Refrigerated Cargo Research Council, the Institute of Refrigeration and the Food Manufacturers Federation. The secretary of the Group is Mr. P. R. P. Claridge, Food Investigation Organisation, Lloyds Bank Chambers, Hobson Street, Cambridge.

Petroleum Films Bureau

It may not be generally known that there exists in London an organisation specializing in circulation (free of charge to responsible bodies such as educational and Service authorities) of 35 mm. and 16 mm. sound and silent documentary instructional films. The August catalogue has reached us from the Petroleum Films Bureau, 46 St. James' Place, London, S.W.1, sponsors of this scheme, from which it is clear that the range of subjects covered is not limited to varying aspects of the oil industry. Titles of general interest include the microscope, microscopy of opaque objects, hydraulics and hospital service. "How Oil is Produced and Refined" is covered by fifteen different reels giving a total of more than three hours showing. Other sections deal with automobile engineering and road safety for children. Short synopses of each film are available; also lantern slides, with appropriate lecture notes, on the subject "About Oil" can be borrowed to illustrate the early history of oil, its nature, origin, production, refining and transportation. This is a valuable scheme, capable of great expansion and certain of support in lecture theatre, classroom, drill hall and, presumably, the home.

Fertilizer Manufacture in East Africa

A scientific mission from East Africa is at present on a short visit to the United States to study the methods employed by the Tennessee Valley Authority in the manufacture of fertilizers. Large deposits of rock phosphates are known to exist in Uganda, and it is expected that the knowledge gained from this visit can be applied to the exploitation of these deposits when hydro-electric power becomes available from the Owen Falls scheme. The members of the mission are: Dr. A. J. V. Underwood, industrial consultant in London to the East Africa High Commission; Mr. H. B. Stent, acting chairman of the East African Industrial Research Board; Dr. K. A. Davies, director of the Geological Survey, Uganda; and Mr. C. R. Westlake, chairman of the Uganda Electricity Board.

Life-Histories of Birds

The United States National Museum has issued a number of bulletins dealing with the life-histories of various North American birds. The latest addition to the series covers the nuthatches, wrens, thrashers and their allies, and is a painstaking work. Mr. Burt, the author, says that he has endeavoured to give as full a life-history as possible of the best-known sub-species of each species, and has written more briefly of the related sub-species, by this method avoiding repetition and duplication. He has amassed much information which is presented in a clear and readable manner, the volume being illustrated by a large number of photographs, mostly excellent ones, the last, of a sage thrasher, being a particularly successful picture.

Edward Livingston Trudeau (1848–1915)

When he was a student at the New York College of Physicians and Surgeons, Edward Livingston Trudeau, who was born on October 5, 1848, was taught to regard tuberculosis as an incurable disease. When, therefore, the celebrated physician Edward G. Janeway in 1873 diagnosed extensive tuberculosis in his left lung, his patient, who had recently graduated and married and whose brother had died of the same disease, felt he was under sentence of death and gave up his practice to spend his last days in the Adirondack Mountains. To his and everyone else's surprise he recovered, and in 1884 established the open-air Adirondack Cottage Sanitarium—the first in the United States. In the isolation of a primitive forest, badly crippled and single-handed, Trudeau preached and practised the gospel of fresh air and extolled

the virtues of rest. Having read a translation of Koch's classic paper on the etiology of tuberculosis, he built himself a modest laboratory in his own home. Out of its ashes sprung the present Saranac Laboratory—the first of its kind in the United States. Trudeau wrote little on clinical subjects; but his laboratory studies are contained in a large number of valuable papers, including experiments on immunity and on the effect of fresh air on tuberculous rabbits. He was the first president of the National Association for the Study and Prevention of Tuberculosis. His optimism and charm endeared him to all his patients, perhaps the most famous of whom was Robert Louis Stevenson.

Convention on High Vacua

THE Society of Chemical Industry is sponsoring a convention on high vacua under the presidency of Sir Charles Darwin, director of the National Physical Laboratory, which is being organised by Mr. L. L. Maitland, director of British-American Research, Ltd., to be held at Gleneagles during October 12–13. Among the topics to be discussed are the applications of high vacua to plastics, dehydration, distillation generally and the distillation of fatty oils, the metallurgical industry and nuclear physics and atomic energy. Full opportunity will be provided for discussion. Information on accommodation and travel arrangements can be obtained from Mr. L. L. Maitland, British-American Research, Ltd., Block E.2, Hillington North, Glasgow, S.W.

Photo-electric Spectrometry Group

AN association has been formed of those interested in instruments for photo-electric spectrometry and their applications. It has been named the Photo-electric Spectrometry Group, without prejudice to its possible future affiliation to an existing scientific body. The inaugural meeting of the Group was held in Cambridge on July 16. Out of about a hundred and twenty who were invited, sixty-four attended. New instruments were on view and papers were read by Dr. E. R. Holiday (London Hospital) on "Adaptation of the Hilger Spekker and Medium Spectrograph for Photoelectric Work", and by Mr. G. H. Beaven (Thornton Research Centre, "Shell" Refining and Marketing Co., Ltd.) entitled "Notes on the Operation, Maintenance and Servicing of the Beckman Model D.U. Spectrophotometer".

The following were appointed officers of the Group: *Chairman:* Dr. J. R. Edisbury, Research Department, Lever Bros. and Unilever, Ltd., Port Sunlight; *Vice-Chairman:* Mr. G. H. Beaven, Thornton Research Centre, "Shell" Refining and Marketing Co., Ltd., P.O.B. No. 1, Chester; *Hon. Secretary:* Mr. W. H. Storey, Unicam Instruments (Cambridge), Ltd., Arbury Works, Cambridge; *Hon. Treasurer:* Mr. J. R. Stansfield, Hilger and Watts, Ltd., 98 St. Pancras Way, London, N.W.1; *Committee:* Mr. C. G. Cannon, Physics Department, University of Reading; Mr. B. S. Cooper, Research Department, General Electric Co., Ltd., Wembley; Dr. J. G. A. Griffiths, A.D.I. (Sc.), Air Ministry, Whitehall, S.W.1; Dr. E. R. Holiday, Research Department, London Hospital, E.1; and Dr. F. Wokes, Ovaltine Research Laboratories, King's Langley, Herts. Subjects on which it is proposed to hold further meetings or whole-day conferences are flame photometry (jointly with the Institute of Physics Industrial Spectroscopic Group), fluorescence, photo-electric recording of spectra, stray light, and reflexion spectra. A bulletin will be issued periodically for private distribution to members and will contain reports of meetings with details of papers and discussions. It will also include abstracts, a question and answer section, and give information about new designs and the location of spares for existing instruments. The subscription is 10*s.* per annum, commencing October 1, and includes the cost of the bulletin. Membership forms can be obtained on application to the honorary secretary.

National Research Council of Canada: Medical Fellowships

MEDICAL fellowships have been awarded by the National Research Council of Canada to thirty-one graduates in medicine to enable them to pursue post-graduate research during 1948–49. Distribution of the awards by the universities at which they will be held is as follows: McGill, 8; Montreal, 1; Queen's, 4; Toronto, 7; Western Ontario, 8; Manitoba, 1; Oxford, 1; Zurich, 1. These fellowships vary in amount from 1,500 to 2,500 dollars, depending on the previous training and experience of the candidates. The Division of Medical Research of the National Research Council also makes grants-in-aid to Canadian universities for medical research studies on approved subjects. During the present year, 118 such grants, valued at 264,173 dollars, are being held. The nominal value of the thirty-one medical fellowships awarded this year is 64,600 dollars.

Physical Society of London: Award of Charles Vernon Boys Prize

THE Charles Vernon Boys Prize of the Physical Society, given annually for distinguished research in experimental physics, is being awarded this year to Prof. S. Tolansky in recognition of his work in interferometry. The Prize will be presented at a meeting of the Society on October 8, when Prof. Tolansky will give an address on "Current Investigations with Multiple-Beam Interferometry". Prof. S. Tolansky has held the chair of physics at the Royal Holloway College, University of London, since 1947, and has done extensive research work in optics and spectroscopy; during the war years he was engaged on research in connexion with atomic energy.

Prof. R. W. Wood, professor of experimental physics at the Johns Hopkins University since 1901 and research professor since 1937, will give an address to the Society before the award of the Charles Vernon Boys Prize, his subject being "Spontaneous Deformation of Crystals". Prof. Wood is receiving an honorary degree of D.Sc. from the University of Oxford.

Lectures on the Atomic Age

THE Sir Halley Stewart Trust has arranged a course of six free lectures on "The Atomic Age", to be given at the Memorial Hall, Farringdon Street, London, on Tuesdays, beginning October 26, at 6 p.m. The speakers will be Prof. M. L. Oliphant, on "The Scientific Achievement"; Prof. P. M. S. Blackett, on "The Military Consequences of Atomic Energy"; Mr. R. F. Harrod, on "The Economic Repercussions of Atomic Power"; Lord Russell, on "Our Scale of Values in the Atomic Age"; Mr. Lionel Curtis, on "The Political Repercussions"; and Prof. D. W. Brogan, on "America as Atlas". For free reserved seats application should be made to the Secretary, Sir Halley Stewart Trust, 167 Strand, London, W.C.1.

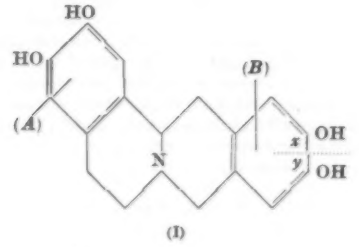
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

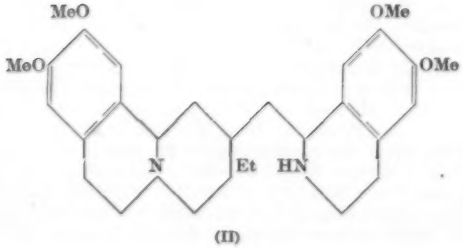
Structure and Biogenesis of Emetine

In making favourable comment on Woodward's ingenious suggestion respecting the biogenesis of strychnine[1], the hope was expressed that further speculation of a similar kind would be based on a comparable "degree of coincidence". The remarkable development mentioned below certainly meets this requirement. It provides an outstanding example of interaction of results in two fields, strengthening theoretical conclusions in both of them.

I noticed that (excluding consideration of the methylation of phenolic hydroxyls) emetine could be constructed from three molecules of dihydroxyphenylalanine and one of the formaldehyde equivalent, assuming a fission of one aromatic nucleus on Woodward's lines. Following these quite closely, it will be noted that the hydroxyl in the meta position to the side-chain of the amino-acid becomes an aldehyde group; that in the para position is found in the alkaloid in a state of oxidation equivalent to that of an alcohol. Postulating exactly the same circumstances in the case of the stages leading, on this hypothesis, to emetine, we arrive without ambiguity at a single formula (II). Thus the *nor*-pseudotetrahydroberberine (I) represents the familiar *nor*-laudanosine of the Winterstein – Trier hypothesis condensed with formaldehyde or its equivalent. What has long been known[2] about emetine proves that our next stage cannot be the degradation of the *A*-nucleus. If we assume the oxidative degradation of the *B*-nucleus, as indicated by the dotted line, and so that *x* becomes a formyl group, and the chain beginning with *y* is fully reduced, and later that the new aldehyde condenses in the usual manner with dihydroxyphenylalanine (decarboxylated at some stage) to an *iso*quinoline derivative; then, after O-methylation, emetine would be (II).



(I)



(II)

No special importance was attached to this speculation until, in the course of a discussion with Dr. M. J. S. Dewar, he wrote down formula (II) as the most likely interpretation of results described in three recent communications[3] on the subject of the chemistry of emetine. Of these, the work of Späth, and of Pailer, solves the problem of the arrangement of carbon atoms in the chain connecting the *iso*quinoline nuclei; that of Karrer and his co-workers supplies a detail which indicates the relation of this carbon skeleton to the tertiary nitrogen.

Thus the constitution (II) appears to be firmly established by these recently disclosed experiments, and by the earlier investigations. It is surely significant that, without knowledge of the recent publications, the same constitution was deduced by applying Woodward's theory of biogenesis of strychnine to a complex member of the *iso*quinoline group.

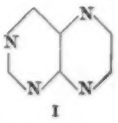
R. Robinson

Dyson Perrins Laboratory,
University, Oxford.
Sept. 5.

[1] Woodward, R. B., *Nature*, **162**, 155 (1948).
[2] Carr, F. H., and Pyman, F. L., *J. Chem. Soc.*, **105**, 1591 (1914); Späth, E., and Leithe, W., *Ber.*, **60**, 688 (1927).
[3] Späth, E., *Monatsh.*, **78**, 348 (1948). Pailer, M., *ibid.*, **79**, 127 (1948). Karrer, P., Eugster, C. H., and Rüttner, O., *Helv. Chim. Acta*, **31**, 1219 (1948).

A Synthesis of Pteridine

Although many derivatives of pteridine, both natural and synthetic, are known, the parent substance pteridine (I) does not appear to have been described. This substance has now been prepared by the condensation of 4 : 5-diaminopyrimidine with glyoxal bisulphite.



I

4 : 5-Diaminopyrimidine has been described by Isay[1], but it is more readily available by a slightly modified procedure. 2-Chloro-4-amino-5-nitropyrimidine, m.p. 232° (Isay, *loc. cit.*, gives m.p. 217°), is hydrogenated in methanol over a nickel catalyst to give 2-chloro-4 : 5-diaminopyrimidine, m.p. 232° (found: C, 33·3; H, 3·7; N, 38·7; Cl, 24·6. $C_4H_5N_4Cl$ requires C, 33·2; H, 3·5; N, 38·8; Cl, 24·5 per cent). Catalytic dehalogenation over palladium on charcoal in the presence of barium oxide gives 4 : 5-diaminopyrimidine, m.p. 204°, which forms a crystalline nitrate decomposing without melting above 260° (found: C, 27·8; H, 4·0; N, 40·0. $C_4H_7O_3N_5$ requires C, 27·7; H, 4·1; N, 40·5 per cent). Reaction of the diaminopyrimidine in aqueous solution with glyoxal bisulphite gives pteridine which crystallizes from alcohol in pale yellow plates, m.p. 140° (found: C, 54·3; H, 2·9; N, 42·9. $C_6H_4N_4$ requires C, 54·5; H, 3·05; N, 42·4 per cent).

Pteridine is soluble in water and alcohol and readily sublimes *in vacuo*. Its ultra-violet absorption spectrum in aqueous solution at *p*H 5·8 shows a sharp maximum at 299 mμ with $\varepsilon = 7{,}890$ (Beckmann spectrophotometer), and in neutral or alkaline solution it shows a violet-blue fluorescence in the ultra-

violet. It forms a picrate m.p. 117·5° (found: C, 35·9; H, 2·8; N, 24·6. $C_{12}H_9O_7N_7.2H_2O$ requires C, 36·2; H, 2·8; N, 24·7 per cent), and an oxalate which decomposes without melting above 128° (found: C, 37·5; H, 3·5. $C_8H_6O_4N_4.2H_2O$ requires C, 37·2; H, 3·9 per cent).

W. G. M. Jones

Imperial Chemical Industries, Ltd.,
Research Laboratories,
Hexagon House, Manchester 9.
Aug. 10.

[1] *Ber.*, **39**, 250 (1906).

Chemical Assay of Streptomycin *B* (Mannosido – Streptomycin)

Morris[1] has recently described the use of a new reagent (0·2 per cent anthrone, a reduction product of anthroquinone, in 95 per cent sulphuric acid) for quantitative determination of carbohydrates. We have found that it can be used not only for distinguishing streptomycin *B* (a mannoside) from streptomycin *A*, but also for estimating the amount of the former present in a mixture. The glucosamine moiety, present in both molecules, apparently does not react with the reagent. Results obtained are in accord with those calculated from biological and chemical assays, making the accepted assumption about the relative biological activities of the two streptomycins.

It is hoped to publish elsewhere details of the analytical procedure, with some typical results.

W. B. Emery
A. D. Walker

Fermentation Division,
Glaxo Laboratories, Ltd.,
Barnard Castle,
Co. Durham.
July 30.

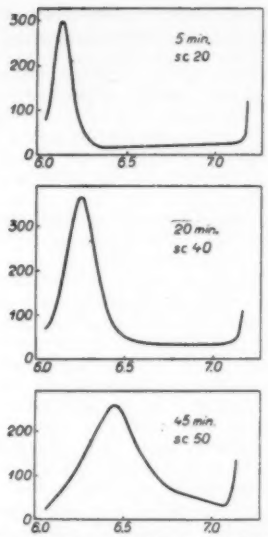
[1] Morris, *Science*, **107**, 254 (1948).

Molecular Weight of Malt-Amylase

In an earlier investigation[1], the molecular weight of α-amylase from pig's pancreas[2,3] was found to be 45,000, as calculated from the values[4] $s_{20} = 4{\cdot}50\ S$, $D = 8{\cdot}05 \times 10^{-7}$ c.g.s. and $V_{20} = 0{\cdot}70$. At this Institute a new method for the isolation of amylase from malt has been developed[5]. It was shown that by repeated purification of the albumin fraction from malt a preparation was obtained with high α-amylase and β-amylase activity. Therefore it was assumed that the amylase activity of malt is localized in the albumin fraction. By ultracentrifugation of the albumin fraction, only one peak was obtained. It must be stated here that malt-amylase is more polydisperse than α-amylase from pancreas.

A determination of the molecular weight was carried out on an amylase preparation with a saccharification activity[6] of 45,000 and a dextrinizing activity[7] of 57,400, calculated for the dry substance. The determination was carried out in a buffer solution with a concentration of 0·2 *M* sodium chloride, 0·03 *M* primary sodium phosphate and 0·02 *M* secondary sodium phosphate, *p*H 7.

Ultracentrifuge measurement. The accompanying sedimentation diagrams were obtained by centrifuging at 65,000 r.p.m.



Sedimentation curves for malt-amylase. In Table 1 the sedimentation constants for different concentrations are shown

Table 1

Conc. of amylase (per cent)	$s_{20}S$
0·19	4·62
0·28	4·44
0·31	4·96
0·32	4·22
0·41	4·76
0·45	4·12
0·75	4·69
1·00	4·44
1·05	4·39

The sedimentation constant is evidently independent of the concentration. An average value of the sedimentation constant is $s_{20} = 4{\cdot}52\ S$.

Diffusion measurement. The determination of the diffusion constant was carried out in exactly the same way as for α-amylase from pancreas[1]. The resulting values of the diffusion constant are shown in Table 2.

Table 2

Diffusion time (sec.)	34,440	79,020	99,960	129,420	Average value
D_m	6·96	6·70	6·70	6·59	6·74
D_A	6·42	6·20	6·29	6·36	6·32

The agreement between D_m and D_A is good. The average value of $D = 6{\cdot}53 \times 10^{-7}$ c.g.s. is used in the following. The value $V_{20} = 0{\cdot}69$ was kindly determined by Prof. C. Drucker. Using these values, the molecular weight of malt-amylase is 54,000. Evidently this value is of the same order of magnitude as that for α-amylase from pancreas. It is an interesting fact that the amylase activity is associated with molecules with about the same molecular weight in both the plant and animal kingdom.

Carl-Erik Danielsson

Institute of Physical Chemistry,
University of Uppsala. May 24.

[1] Danielsson, C.-E., *Nature*, **160**, 899 (1947).
[2] Meyer, K. H., Fischer, E. H., and Bernfeld, P., *Experientia*, **2**, 362 (1946); *Helv. Chim. Acta*, **30**, 64 (1947).
[3] Fischer, E. H., "La purification et l'isolement de l'α-amylase de pancréase". Thèse No. 1094 (Genève, 1947).
[4] Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge" (Oxford, 1940).
[5] Danielsson, C.-E., and Sandegren, E., *Acta Chem. Scand.*, **1**, 917 (1947).
[6] Windisch, W., and Kolbach, P., *Woch. Brau.*, **42**, 139 (1925).
[7] Ehrnst, L. E., Yakish, G. J., and Olson, W., *Cereal Chem.*, **16**, 724 (1939).

Action of Oxalyl Chloride on the Aromatic Hydrocarbons

THE action of oxalyl chloride on an aromatic hydrocarbon in the presence of anhydrous aluminium chloride and in a solvent (for example, carbon disulphide) can lead to the production of the aromatic acid as the chief reaction product. This may provide, too, a general method for the synthesis of *p*-alkylbenzoic acids[1].

Schönberg and Kraemer[2] isolated *p*-ethylbenzoic acid only by the interaction of oxalyl chloride, ethylbenzene, and aluminium chloride in carbon disulphide solution at a low temperature. No mention was made of the yield of the acid. On repeating their experiment and modifying the procedure so as to extract the acid directly from the reacting mixture with a dilute alkali solution, *p*-ethylbenzoic acid (m.p. 112–113°) was obtained in 43 per cent yield, rising to 66 per cent if equimolecular amounts of the substances interacted at room temperature. *p,p'*-Diethyldiphenyl ketone was also isolated.

The action of oxalyl chloride on the higher *n*-alkylbenzenes, under similar conditions, led to the formation of the corresponding *p*-*n*-alkylbenzoic acids in satisfactory yield. Results are shown in the accompanying table.

Action of oxalyl chloride on alkylbenzenes in carbon disulphide in presence of aluminium chloride at room temperature

Alkylbenzene	Acid formed	Yield of acid (%)
Toluene	*p*-toluic	60
Ethylbenzene	*p*-ethylbenzoic	66
n-propylbenzene	*p*-*n*-propylbenzoic	70
n-butylbenzene	*p*-*n*-butylbenzoic	50
n-amylbenzene	*p*-*n*-amylbenzoic	50
n-hexylbenzene	*p*-*n*-hexylbenzoic	40
n-heptylbenzene	*p*-*n*-heptylbenzoic	40
n-octylbenzene	*p*-*n*-octylbenzoic	3

The yield of the *n*-octylbenzoic acid was exceptionally low. This might be due to the fact that the reaction was not complete at room temperature.

HUSSEIN AHMAD FAHIM
Chemistry Department,
Faculty of Science,
Fouad I University,
Abbassia, Cairo.
May 4.

[1] Comp. Zaki and Fahim, *J. Chem. Soc.*, 307 (1942).
[2] *Ber.*, **55**, 1174 (1922).

Selective Development of Fission Tracks in an Electron-sensitive Emulsion

THE interpretation of records of nuclear reactions occurring in photographic emulsions is materially assisted by differences in the solidity and grain-frequency of tracks produced by particles of different ionizing power[1]. Discrimination between tracks of various particles can be enhanced by using emulsions with a range of intrinsic sensitivities[2]; to a lesser extent by varying development time and composition of developer[2,3]; or by applying oxidizing solutions between exposure and development[4].

Special emulsions have been produced which are sufficiently sensitive to record tracks of electrons[5,6], whereas at the other end of the range there are emulsions sensitive only to tracks of fission fragments[7,8]. The advantage of the latter is, of course,

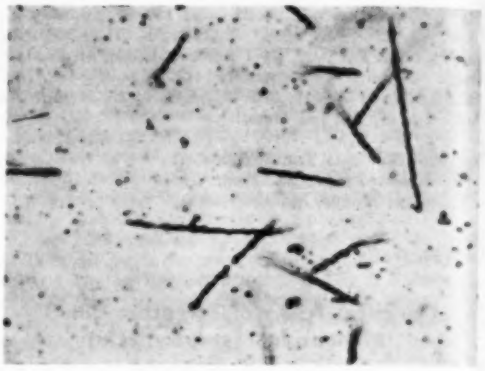


Fig. 1. Photomicrograph of tracks from uranium layer, dipping into NT.2*a* emulsion. Development 10 min. D.19*b*

that fission fragments alone can be recorded in spite of a heavy background of radiation from other less strongly ionizing particles.

It would be very convenient to be able to utilize an electron-sensitive emulsion for the selective recording of fission tracks, so that this whole range of results could be spanned with a single emulsion. A means of achieving this result by controlled under-development is the subject of the present communication.

Deliberate under-development implies that the development process will be stopped before all the exposed emulsion grains have been developed. Control of the results (particularly with thickly coated emulsions) is therefore facilitated by the use of long development times with severely restrained and slow-working developers. In preliminary tests it was noticed that a para-aminophenol solution, used at such a low *p*H that it would not even develop alpha-particle tracks, still gave strong development of abrasion marks in the emulsion surface. It seemed possible that such a solution would also develop fission tracks.

Glass plates were coated with a suspension of ammonium diuranate in gelatin (equivalent to 0·01 gm. uranium/cm.^{3}). These were packed in contact with 'Kodak' NT.2*a* plates, which have previously been shown to be capable of recording electron tracks[5,6]. Some of these were shielded with $\frac{1}{8}$ in. of lead and exposed to a flux of 5×10^{11} neutrons per cm.^{2} of plate in the nuclear pile at Harwell.

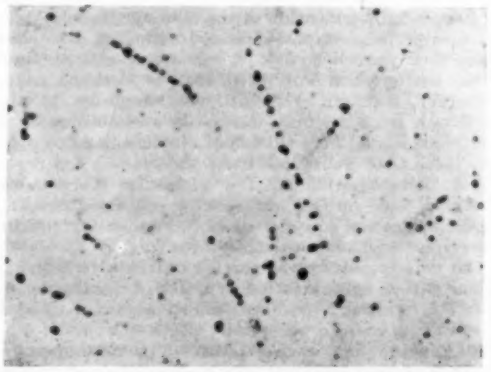


Fig. 2. Tracks given by 40-min. development in a low-energy para-aminophenol developer (solution I)

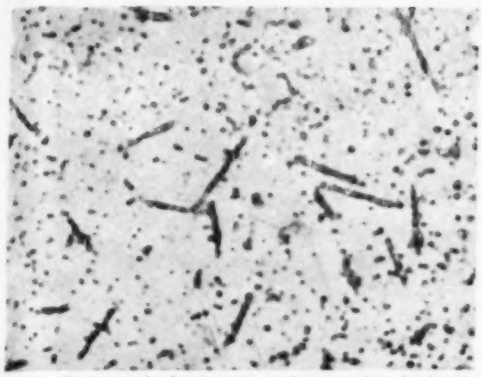


Fig. 3. Fission tracks dipping into emulsion on plate developed in solution I after exposure in the pile in contact with uranium

Strips exposed in the pile ('pile-plates') and controls left in contact with uranium only were developed for ten minutes at 70° F. in D.19*b* and for forty minutes in special low-energy para-aminophenol developers. These were prepared from three stock solutions: (*A*) contained 15 per cent para-aminophenol hydrochloride and 2½ per cent $NaH.SO_3$; (*B*) 5 per cent $Na_2PO_4.12H_2O$, 4 per cent Na_2SO_3 and 0·4 per cent KBr; and (*C*) 5 per cent $Na_2HPO_4.12H_2O$, 4 per cent Na_2SO_3 and 0·4 per cent KBr. Solution I contained 2 c.c. *A*, 20 c.c. *B* and 80 c.c. *C*. Solution II contained 2 c.c. *A* and 100 c.c. *C*.

The pile-plates developed a density of 4 in an 'Elonhydroquinone' developer (Kodak formula D.19*b*), and no tracks could be seen because of the high opacity, while the control showed solid alpha tracks (Fig. 1). In contrast to this, solution I produced on the control plates alpha tracks showing as tenuous chains of grains (Fig. 2), and the pile plate developed a density of only 0·5. Under the microscope, the latter showed solid fission tracks readily distinguished from the residual background (Fig. 3). Solution II, an even weaker developer, showed no alpha tracks at all, but still gave recognizable fission tracks on the pile plate (Fig. 4). Perfilov[4] obtained similar discrimination between alpha and fission tracks by treating the exposed plates in a dilute chromic acid bleach before development. We have been able to confirm the general nature of this result,

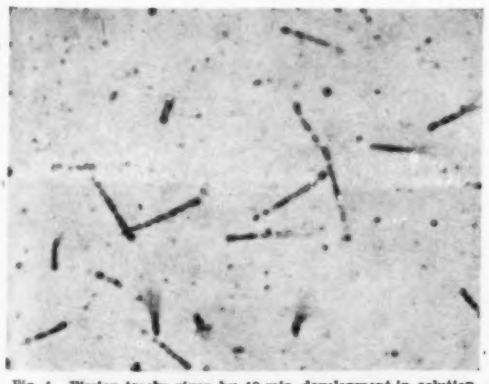


Fig. 4. Fission tracks given by 40-min. development in solution II, which cannot develop alpha tracks at all

and preliminary comparisons indicated that the discrimination is surprisingly similar to that given by these special para-aminophenol developers.

Similar discrimination has also been obtained by using 'Elon' (methyl *p*-aminophenol sulphate), glycin and hydroquinone in solutions adjusted to give about the same development activity. The effect is thus not exclusive to one developing agent, but para-aminophenol and 'Elon' gave the more attractive results. Discrimination has also been obtained by adding progressive concentrations of potassium bromide to these solutions at higher *p*H values. On the other hand, substantially no discrimination between alpha and fission tracks was obtained by developing for only one minute in D.19*b*. A continuously graded series of developers can also be conveniently prepared by raising the proportion of stock solution *B* to increase the *p*H and developer activity, and some of these more active developers give considerable discrimination between alpha particle and proton tracks.

Considerable advantage may accrue if procedures of this type can be standardized without excessive trouble. The results given by such gross under-development are, however, likely to be particularly sensitive to small variations of temperature or composition. Reproducible results may, therefore, only be obtained by performing the development operation with the care used in other physico-chemical experiments.

I wish gratefully to acknowledge the help of the Director, Atomic Energy Research Establishment, Harwell, in obtaining neutron exposures, and to thank him for permission to publish these results which were obtained while working under contract to the Establishment.

G. W. W. Stevens

Research Laboratory,
Kodak, Ltd.,
Wealdstone,
Harrow, Middlesex.
July 30.

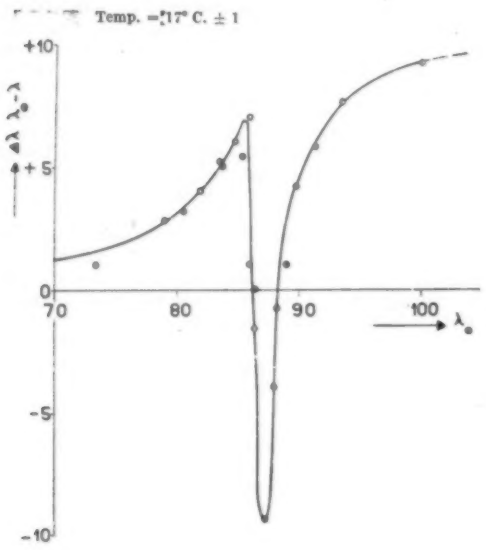
[1] See, for example, Powell, C. F., and Occhialini, G. P. S., "Nuclear Physics in Photographs" (Clarendon Press, Oxford, 1947).
[2] Powell, C. F., Occhialini, G. P. S., Livesey, D. L., and Chilton, L. V., *J. Sci. Inst.*, **23**, 102 (1944).
[3] Demers, P., *Can. J. Res.*, **25**, 225 (1947).
[4] Perfilov, N. A., *C.R. Acad. Sci. U.R.S.S.*, **42**, 258 (1944).
[5] As reference 3.
[6] Berriman, R. W., *Nature*, **161**, 432 (1940). Herz, R. H., *Nature*, **161**, 928 (1948).
[7] Borst, L. B., and Floyd, J. J., *Bull. Amer. Phys. Soc.*, **21**, No. 3, 13 (1946).
[8] Green, L. L., and Livesey, D. L., *Nature*, **158**, 272 (1946), obtained a similar result from incidental desensitization occurring when plates were bathed in uranyl acetate.

Anomalous Magnetic Behaviour of Nickel–Iron at High Frequencies

In the course of a series of experiments that is being carried out under the direction of Miss H. J. van Leeuwen in this Laboratory in order to determine the high-frequency magnetic permeability of ferromagnetic materials, a peculiar property of a nickel–iron alloy has been found.

Two concentric Lecher systems are used in the experiments, the outer conductor of both being made of copper, while the inner conductor of one is a copper wire, that of the other a nickel–iron wire (35 per cent nickel, 65 per cent iron). Both systems are coupled to an oscillator and the wave-lengths of standing waves are measured.

It can be shown mathematically that for a magnetic permeability μ greater than 1 of the ferromagnetic material, the wave-length λ for the ferromagnetic wire is smaller than the wave-length λ_0 for the copper wire. The results of the measurements in the interesting range are shown in the accompanying graph, the abscissa representing λ_0, which is practically equal to the wave-length *in vacuo*, while the ordinate signifies the difference $\Delta\lambda = \lambda_0 - \lambda$.



The graph resembles strikingly an anomalous dispersion curve. In a narrow interval, between $\lambda_0 = 86$ and 88 cm., the wave-lengths on the nickel–iron wire become considerably larger than those on the copper wire, which means that μ there is smaller than unity or even negative.

Similar experiments have been carried out previously in this Laboratory by J. Smidt[1] with a pure iron wire. This showed no anomalous behaviour except that the descent of the curve to zero near $\lambda_0 = 60$ cm. was much steeper than could be expected from theory[2]. A possible explanation would be that the wave-length for the anomalous behaviour of iron falls just in this region, the minimum of the curve being obliterated because the magnetic susceptibility of iron disappears below 60 cm.

It is expected that these and further experiments will reveal new information on the internal conditions of ferromagnetic materials.

A. Wieberdink

The experiments just described can be interpreted in their essence by assuming that the magnetization induced in the material of the wire by a harmonically varying magnetic field is represented by a function of the frequency of the same type as that met with in the case of the electric polarization for a system subject to a harmonically varying electric field and possessing a resonance frequency.

As is well known[3], the magnetization in ferromagnetic substances in general is built up from three contributions: the irreversible displacements of the boundaries of the Weiss domains, the reversible displacements of these boundaries and the change in direction of the magnetic moments of such domains by the external field. At the frequencies and field-strengths here considered, the first cause is no longer operative[3]. The reversible motion of a boundary will, it is true, have a certain characteristic frequency of oscillation about its equilibrium position; but this will depend on local conditions such as stress, impurities, etc., and hence will vary from one boundary to another, thus not giving rise to a well-defined resonance frequency for macroscopic pieces of material. In its orientation, however, the resultant magnetic moment of a Weiss domain is bound to the crystal field, tending to give it preferential directions with respect to the crystal axes (while strong stress or the influence of a constant external magnetic field may supersede the crystal field). In consequence, the magnetic moment will precess about the preferential direction, and it is this precession frequency which acts as resonance frequency for the magnetization. In nickel the crystal field is equivalent to a magnetic field of about 100 oersted, whereas for iron the value is several times as large[3]. The double Larmor frequency in a field of that strength is about 3×10^9 Hz. In other words, it is located just in the proper frequency-range. As in the theory of electric polarization, an absorption will be associated with the anomalous dispersion, which can be described by a line-breadth. This is determined by the natural transition probability of the magnetic moment between its different stationary states in the crystal field, the transitions being brought about by the coupling of the magnetic moment with the conduction electrons and the lattice waves.

An investigation of the influence of stress and of a constant external magnetic field on the value of the resonance frequency will be very instructive and is being planned.

A more detailed discussion of the experiments as well as of the theory will be given in *Applied Scientific Research*.

R. Kronig

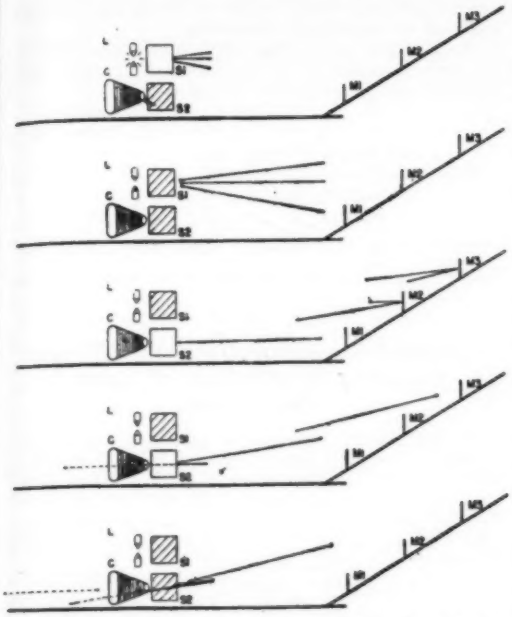
Laboratory for Technical Physics,
Delft.
May 14.

[1] Smidt, J., *App. Sci. Res.*, B, **1**, 127 (1948).
[2] van Leeuwen, H. J., *App. Sci. Res.*, B, **1**, 135 (1948).
[3] Becker, R., and Döring, W., "Ferromagnetismus" (Berlin, 1939).

Brief Light Pulses using Kerr Cells

In connexion with certain studies of electrical discharges, we have found it necessary to develop an extremely fast shutter for photography. The electro-optic Kerr effect is used. Mounted 5·1 mm. apart in nitrobenzene in a glass Kerr cell, the electrodes are 12·7 mm. wide and 20·3 mm. long. Selected pieces of 'Polaroid *J*' film are placed outside the fused-on windows. The cells are subjected to single pulses of about 12,500 volts from a hydrogen thyratron and *RLC* pulse-forming network, thus admitting light to the lens of an ordinary camera. We have been photographing such intensely self-luminous objects as sparks and electrically exploded wires with exposures of a microsecond or less.

We report here a side-experiment designed to show directly the length of the segment of a light beam that we have been able to chop off with a Kerr cell.



L, light source; *C*, camera; *S* 1, 2, Kerr cell shutters; *M* 1, 2, 3, mirrors

In this experiment, two shutters, separated by an optical path of a few metres, were arranged to be pulsed in sequence. If the second shutter were thus opened at a suitable moment following the opening of the first, to allow for the transit time of the light between them, a source of light in front of the first shutter could be photographed by a camera behind the second. If the time delay of the second shutter were appreciably different from the transit time, no light reached the camera. The light source was a wire electrically exploded just previous to the opening of the first shutter.

For convenience, the optical path was folded by using a plane mirror, so that the camera was just below the source. In our experiment, not one but several mirrors were used. These were all so placed as to be illuminated by the source, and all were in the field of view of the camera. Thus several optical paths were set up, each with its own mirror (see accompanying diagram). Since successive mirrors were separated by 30 cm., the optical path differences were 60 cm. By virtue of the finite speed of light, a brief sequential pulsing of the two shutters should, in any given exposure, show not all the mirrors to be effective in reflecting the light pulse. The accompanying photographs show the mirrors, located 30 cm. apart. Certain of them are seen to reflect the light; from a count of these, the length of the light segment may be estimated. By altering the relative timing of the shutters, the reflexions can be made to appear in the near mirrors or the far mirrors.

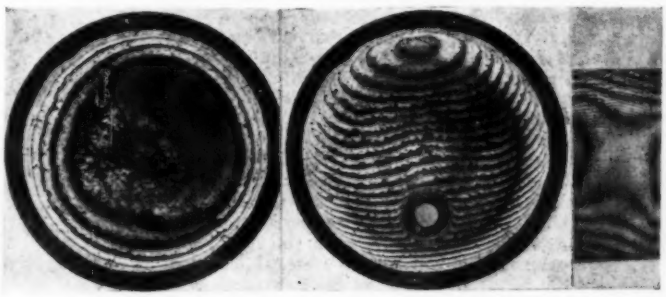
For a semi-quantitative estimate of the length of the beam segment, the method was to compare visually the density of the photographed reflexions in two negatives, one of which had been exposed to two flashes and the other to a single flash. It was noted that seven of the images on the double exposure are more intense than the brightest image on the single exposure. From this it is deduced that the measured length of the beam, between half-intensity points, is about 4·2 m. Neglect of the inverse square law is approximately justified. This measured length depends upon the speed of the second shutter as well as that of the first. If we make the plausible assumption that the voltage applied to each shutter is a similar Gaussian function of time and calculate therefrom the variation of the transmittance of either shutter during the pulse, the distribution of the exposure among the several photographic images is predicted to be approximately Gaussian with a width at half-maximum which is about 23 per cent greater than that of either shutter. The actual length of the beam is thus $4{\cdot}2/1{\cdot}23 = 3{\cdot}4$ m. between half-intensity points. Furthermore, since 70·7 per cent of the area of the shutter transmittance function lies between abscissæ only 78 per cent as far apart as its half-value points, we may say that the effective length of the beam is only 2·7 m. Its duration is therefore 270 jiffies, or about 9×10^{-9} second. This last figure is in good agreement with the value calculated from the oscillogram of the pulses applied to the Kerr cells.

W. M. Cady
A. M. Zarem

U.S. Naval Ordnance Test Station,
Pasadena Annex,
Pasadena, California.
July 23.

Liquid Surface Interferometry

The property that liquid surfaces have of indicating level is frequently employed in physical and engineering metrology. Surprisingly little use is made of the property of flatness which, with certain reservations, is possessed by a reasonably extensive liquid surface, which provides a naturally reproducible reference basis. The earth's radius of curvature causes the centre of a liquid surface of 25 cm. diameter to project by only 12 A. above the true plane intersecting its



1 2 3

1 and 2 show two depositions of fringes in a liquid paraffin layer floated on a lapped cast-iron surface, and indicate that, apart from slight concavity at the centre, the metal surface is generally convex in shape. 3 shows two fringe systems obtained when a wedge plate of glass (20 cm. × 10 cm.) is supported over the liquid surface. *N.B.*—1 fringe in liquid paraffin and glass is equivalent to 0·18 μ; in air the equivalent is 0·27 μ

perimeter, if the effect of capillary curvature at the boundary region is omitted from consideration.

Preliminary experiments at the National Physical Laboratory, with a liquid surface serving as the reference plane in one of the usual arrangements of a Fizeau interferometer[1], have yielded very promising results over a field of 25 cm. diameter. We find, however, that Rayleigh described long ago the use of a water surface for similar purposes during a Royal Institution lecture[2]. Our experiences are much the same as those described by Rayleigh, except that we find it important to use liquids of higher viscosity than water to avoid the vibrational troubles which he reported. Among the liquids we have tried are a micrometer oil (Price's 'Albaline') and glycerine; but the most successful is medicinal liquid paraffin, because it requires no special site or anti-vibration arrangements and yet flows fairly easily. The capillary curvature is also less extensive than that reported for water by Rayleigh. It is necessary to work with a clean surface and to shield it from air draughts. An interesting effect is the unusual response to vibrations observed in the neighbourhood of any sudden and marked change in the depth of the liquid layer.

An important item of the equipment we use is a simple plano-convex lens of 38 cm. diameter ($F/5$) acquired from war surplus stocks of optical components. This is arranged horizontally as the collimating lens of the Fizeau interferometer and directs a beam of parallel monochromatic light vertically downwards on to a lapped cast-iron surface plate of 30 cm. diameter supported on three levelling feet. The liquid paraffin layer, about 3 mm. in thickness, is floated on the metal surface and retained by paper strip gummed round the periphery of the plate. The disposition of the fringes which are produced by two interfering beams, one partially reflected from the liquid surface and the other totally reflected from the metal, is controlled with the levelling feet.

The three interferograms reproduced were obtained in mercury green light using exposure times of 5–20 sec. with Ilford *HP2* plates (6 cm. × 4 cm.). No. 1 shows fringes—rather like a system of Newton's rings—produced over the lapped surface plate when symmetrically disposed to the liquid surface. The black border represents the boundary region from which no light is received owing to capillary curvature. This effect extends into the region from which light is received but vanishes at about 2·5 cm. from the boundary. No. 2 shows fringes over the same plate when slightly inclined to the liquid surface. The white disk represents the end of a 1-in. diameter Hoffmann roller standing in the liquid. A disturbance due to capillary curvature extends about 2·5 cm. outwards from the cylindrical surface which, like the gummed paper, is wetted by the oil.

As glass and liquid paraffin have nearly the same refractive index it is preferable to support glass plates over the liquid surface during examination. In No. 3 the widely spaced fringes are produced by interference in the air film between the liquid and the lower surface of a glass plate 1 cm. thick. The closely spaced system is due to the two surfaces of the glass plate itself and shows that it is wedge-shaped.

We direct attention to this use of a liquid surface as an interferometer mirror because it may have many applications, especially for studies of the physical properties of liquids. It has many obvious advantages as a ready means of verifying large flat surfaces of a precision character.

A fuller account of this work, forming part of the research programme of the National Physical Laboratory, will be published elsewhere.

H. Barrell
R. Marriner

Metrology Division,
National Physical Laboratory,
Teddington, Middx.
June 25.

[1] Williams, W. E., "Applications of Interferometry", 64 (Methuen, 1948).

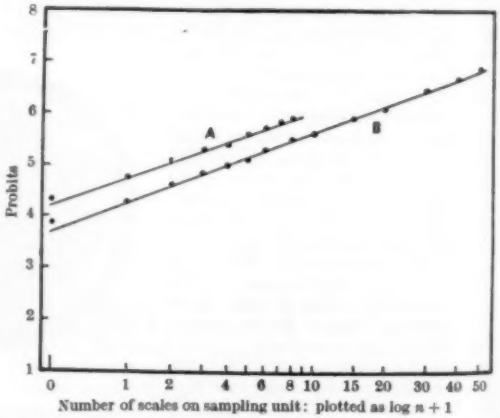
[2] Rayleigh, Lord, *Proc. Roy. Inst. Lond.*, **14**, 72 (1893); *Nature*, **48**, 212 (1893).

Truncated Log-Normal and Root-Normal Frequency Distributions of Insect Populations

In entomology it is usual to find that the numbers of insects or their eggs occurring in each sampling unit are not distributed normally, the many lesser and zero values causing the distribution to be extremely skewed. When such distributions occur, the gross deviations from normality invalidate the use of classical biometrical methods.

I have found such markedly skew distributions of the number of red scales (*Aonidiella aurantii* Mask.) on individual citrus leaves and of the number of eggs laid by *Anobium punctatum* females. It has been found that these two cases can be plotted as straight lines when the probit methods suggested by Gaddum[1] are used, and it appears that these methods may give a solution of other skewed distributions. The red scale data required a logarithmic transformation of the enumeration variable, the *Anobium* data, a square root transformation. The usual device of plotting $n + 1$ instead of the number n has been adopted to allow zero values to be plotted on a logarithmic scale.

As illustration of the degree of linearity achieved by probit methods, the data for red scales on citrus leaves as given in the table, and that of Upholt and Craig[2] for black scales on citrus twigs, have been so plotted in the figure.



Degree of linearity achieved by probit methods. Line *A*, black scales on citrus twigs (Upholt and Craig[2]). Line *B*, red scales on citrus leaves

Frequency distribution of red scales on 720 citrus leaves

Number of scales per leaf	Observed frequency	Number of scales per leaf	Observed frequency	Number of scales per leaf	Observed frequency
0	89	22	7	47	1
1	79	23	4	50	1
2	78	24	7	52	2
3	58	25	5	53	1
4	51	26	3	55	1
5	30	27	3	57	2
6	39	28	8	59	1
7	34	29	2	60	1
8	27	30	5	62	2
9	18	31	2	65	1
10	13	32	2	74	1
11	12	33	2	78	1
12	19	34	2	80	1
13	16	35	1	81	1
14	13	36	1	88	1
15	6	37	4	94	1
16	12	38	1	96	2
17	6	39	2	103	1
18	5	41	2	105	1
19	8	42	2	185	1
20	6	44	5	241	1
21	5	45	1		

Marked breaks and changes of slope occur with some published data; but these may be due to sampling of mixed populations.

The truncation to the left apparent in the figure can be eliminated by increasing the size of the sampling unit until zero values do not occur. When this was done with red scale using counting units of twenty leaves, it was found that the frequency distributions of these units were still log-normal. After the six twenty-leaf values of each of thirty trees had been transformed to logarithms, Nayer's test[3] showed that the various populations could be regarded as having a common variance and thus normal statistical methods could be used. The obvious method of overcoming difficulties arising from truncation of these curves is an increase in size of sampling unit; but if it is necessary to compare data already collected this device may not be available.

From the ease with which data can be reduced to a series of straight lines, it appears preferable to assess significance of differences between two or more sets by linear regression methods, rather than argue back to parent distributions. The usual methods of calculating regressions and their variance cannot be used because points other than the first are not independent. Methods of calculating regressions and variance of such transformed data do not appear to be available, but are required before the utility of probit methods in handling skewed distributions can be determined.

The data and plots of *Anobium* egg-laying are being published elsewhere[4].

D. SPILLER

Plant Diseases Division,
Auckland, New Zealand.
July 26.

[1] *Nature*, **156**, 463 (1945).
[2] *J. E. Ent.*, **33**, 113 (1940).
[3] *Stat. Res. Mem.*, **1**, 38 (1936).
[4] *N.Z. J. Sci. and Tech.* (In the press).

Photographic Evaluation of Blackout Indices

DURING the act of blinking the pupils are masked by the upper lids for an appreciable fraction of a second (*c.* 0·1–0·3 sec.) and, in consequence, vision is intermittent. The *blackout index* expresses the percentage of vision during which one is unsighted, and is obtained from the ratio of the blackout and interblink periods, the normal average value of the latter being for men and women *c.* 3·3 sec. In conversation, the average interblink period is only *c.* 2·7 sec.[1].

Average time constants of blinking can be assumed for a large group of individuals, so that in group photography one can expect that at any instant a definite percentage of the subjects (the average blackout index) will be unsighted and have their eyes almost or wholly closed. Examination of group photographs of a total of sixty-one subjects revealed that roughly one-tenth of them were photographed during the act of blinking, in reasonable agreement with the expected result[2]; but it seemed desirable to examine further photographs of groups and thus obtain the average blackout index for people in general.

It is essential that the time of exposure should be less than the blackout period (that is, $< 0{\cdot}1$ sec.), for blinks will not be revealed clearly in exposures greater than the duration of a blink (0·3–0·4 sec.). Occasionally, even in time exposures, the eyes may appear somewhat blurred. It is therefore important to ensure that such group photographs are either snapshots or flashlight photographs which satisfy the above condition. This is not always easy. Momentary exposures of a group of people occasionally reveal no blinks, whereas, especially with small groups, as many as one-half the subjects may have closed eyes. Many photographs are useless for the purpose in view, if the eyes of all the subjects are not clearly visible.

During the past year I have examined a large number of photographs to ascertain with greater accuracy the average blackout index for people in general. I have also examined many time exposures to confirm that they do not reveal blinks. No evidence of a blink was found in several group photographs taken about fifty years ago, all posed and certainly time exposures. A series of departmental group photographs of students taken during the past twenty-nine years, and all known to be time exposures, yielded only two instances of closed eyes in a total of more than a thousand subjects. Possibly these two were resting their eyes in anticipation of being photographed. On the other hand, in a large number of snapshot and flashlight photographs of a total of 2,140 subjects, 215 had closed eyes. On this evidence it seems certain that the general average blackout index does not deviate appreciably from 10·0 per cent for light-adapted eyes (pupil diameter, 3–4 mm.).

It follows that the general average *blackout period* will be 0·33 or 0·27 sec., according to which of the general average interblink periods (3·3 or 2·7 sec.) is used. As the conditions under which snapshot or flashlight photographs are taken are more often conversational than normal restful ones, the second value of the blackout period is likely to be the true one. This value lies between the limits mentioned earlier, and it is interesting to note that Miss M. P. Lord and W. D. Wright recently determined the former's blackout period to be *c.* 0·2 sec.[3].

It is clear that individual blackout indices could be determined by examination of a large number of random photographs of one and the same individual, though the process would be rather tedious. In a popular form of multiple photography, blinks can often be noticed—in one case I saw four in a total of forty-eight photographs—but it seems doubtful

whether these multiple photographs are sufficiently random and unposed to serve as a basis for the determination of individual blackout indices.

ROBERT W. LAWSON

Department of Physics,
University, Sheffield, 10.
Aug. 10.

[1] Hall, Sir Arthur, *Brit. J. Ophthal.*, **29**, 446 (1945).
[2] Lawson, R. W., *Nature*, **161**, 154 (1948).
[3] Lord, Mary P., and Wright, W. D., *Nature*, **162**, 25 (1948).

Variation of Ground-Levels on Coe Fen, Cambridge

SOME interesting and considerable variations in level were noticed on Coe Fen, Cambridge, after the floods of 1947. A portion of the Fen is used by the Engineering Department, University of Cambridge, for practical exercises in surveying. For this purpose, concrete blocks approximately 1 ft. 0 in. square by 1 ft. 6 in. deep have been sunk into the ground to form the survey stations, the actual station being taken as the centre of a steel tube cast solid with the concrete block and projecting slightly above the surface of the block. These stations are grouped into closed polygons.

Small vertical movements of these blocks are known to take place, and have usually been attributed to frost heave. For this reason, the differences in level between all these blocks are carefully checked before the surveying course begins each summer, so that the accuracy of the students' levelling may be checked.

After the floods of 1947, during which practically the whole of this area was inundated, this check was carried out as usual, and very much larger movements than had hitherto been found were encountered. Unfortunately, the absolute levels of these blocks have never been measured with respect to some fixed and stable bench-mark, so that only their relative movements can be measured. However, between the summers of 1946 and 1947, either the south end of the Fen has lifted, or, more likely, the north end has sunk about 0·2 ft., a considerable amount in a distance of about 2,000 ft. The levels were rechecked in April of this year, and little difference was found from the previous year's figures, only slight movements, of the order of 0·03–0·04 ft., having taken place.

The nature of the ground was investigated in an endeavour to shed some light on the cause of these movements. Borings were made near three of the stations. At all these points, similar conditions were found. After about six feet of gravel, some clay was encountered. This was at first thought to be the thick underlying stratum of gault known to exist in this area. However, further boring revealed that this layer of clay was only about one foot thick, and that below this was a layer of what might best be described as liquid mud, into which the soil borer could be pushed by the weight of the body, without any twisting action being necessary. This liquid mud was about four feet thick. In some of the borings a layer of peaty substance was found at the bottom of the gravel.

E. G. STERLAND

Engineering Laboratory,
University,
Cambridge.
June 26.

Work-Hardening Under Complex Stresses

PLANE stress yielding was induced in a duralumin plate by expanding a 12-segmented cylindrical collet. The tangential strains in the plate were measured at ten values of radius by means of single-filament Minalpha resistance wire strain gauges[1]. At all loads the measured strains in the unyielded portion of the plate fitted the theoretical solution exactly. The measured values in the yielded zone from the inner radius out to the yield boundary are shown for a typical loading in the figure.

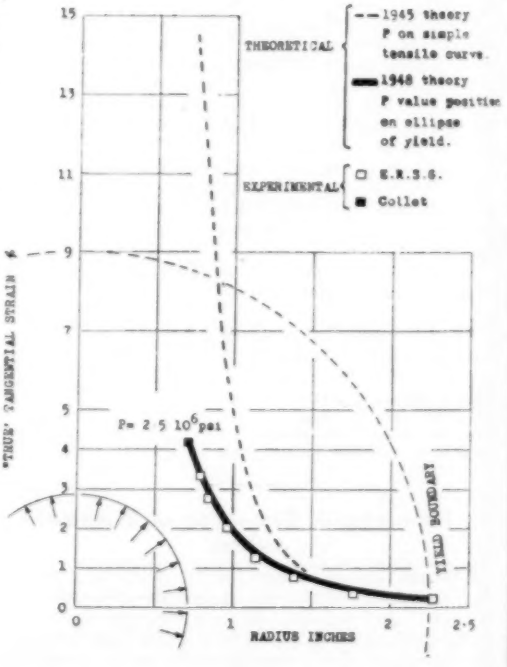
The experiment was designed to check the particular solution in my 1945 theory on post-yield stress-strain compatibility[2], but with the 1947 extension to any severity of deformation[3], since the experimental strains were large at the higher loads. The stress-strain relations for this plane-stress problem in polar co-ordinates (r, θ) are,

$$e_r = \frac{1}{E}(S_r - qS_\theta) + \int_{S_r^0}^{S_r}\left(\frac{1}{P} - \frac{1}{E}\right)dS_r - p\int_{S_\theta^0}^{S_\theta}\left(\frac{1}{P} - \frac{1}{E}\right)dS_\theta, \quad (1)$$

with the expression for e_θ written by interchange of r and θ and in which e can be nominal strain for small strains or 'true' for any finite magnitudes[3,4], E the elastic modulus, P the inelastic modulus, S stress, q and p elastic and plastic transverse contraction ratios respectively, while superscript 0 denotes the stress operating when the element first yields. The stresses must satisfy the extended Huber – Mises – Hencky yield criterion[3]

$$S_r^2 - S_rS_\theta + S_\theta^2 = Y^2, \quad (2)$$

the equations of equilibrium and the boundary con-



ditions as well as (1). The normal stress Y is 'equivalent' to the complex system.

Comparison of the measured strains with the theory showed that in the duralumin of the plate the stress-strain parameter P obeyed the relationship,

$$\frac{1}{P} = fY, \qquad (3)$$

with f of value $3{\cdot}57 \times 10^{-12}$ (psi)$^{-2}$. In the 1945 theory[2] P was taken as the slope of the simple tensile stress-strain curve at stress Y. Thus for duralumin in simple tension f is of value 172×10^{-12} (psi)$^{-2}$, and if this value is used in the theory would give the curve shown in the figure. It is important to note that this erroneous assumption is involved in all the recent theories in which the stress-strain parameters are assumed as functions of only octahedral shear stress[5,6].

The duralumin is 'stiffer' under the compression-tension stresses in the expanded plug test than it is under simple tensile stress. This led me to analyse tests by Davis[7] on thin-walled tubes under axial tension and internal pressure inducing tangential tension. Under the tension-tension stress loading the steel was 'less stiff' than under simple tension. Thus it appears that the strain change accompanying a stress change depends on the signs and magnitudes of the orthogonal stress components as well as on the equivalent normal or octahedral shear stress[8].

K. H. Swainger
Imperial College of Science and Technology,
City and Guilds College,
South Kensington, London, S.W.7.
March 14.

[1] Swainger, K. H., *Nature*, **159**, 61 (1947).
[2] Swainger, K. H., *Phil. Mag.*, **36**, 443 (1945).
[3] Swainger, K. H., *Phil. Mag.*, **38**, 422 (1947).
[4] Swainger, K. H., *Nature*, **160**, 399 (1947).
[5] Nadai, A., *Proc. Inst. Mech. Eng., Lond.*, **157** (1947).
[6] Prager, W., *A.S.M.E.* Paper No. 48—APM.14 (1948).
[7] Davis, E. A., *J. App. Mech.*, **12**, No. 1 (1945).
[8] Swainger, K. H., "Severe Deformations", March 1948, to be read to the Seventh International Congress on Applied Mechanics, Imperial College, London (Sept. 1948).

Genetics of Style-Length in *Oxalis*

Among the tristylic plants which have attracted the attention of geneticists, without the genetic situation being fully elucidated, is *Oxalis valdiviensis*. Two years ago, work was started in this Department by setting out twelve short-styled plants for open pollination by long, as this method had proved successful in the case of *Lythrum salicaria*.

Of the twelve progenies grown in 1947, six threw no mid-styled plants, giving 363 *L* : 319 *S*. The remaining six families, which contained mids, gave 24 *L* : 329 *M* : 336 *S*, showing that the short parent was segregating for a factor for mid style-length, though not so as to give a 1 : 1 : 2 ratio, as with *Lythrum salicaria*.

This result suggested the possibility that the genes for short and mid were rather closely linked, with about 6·8 per cent recombination, and that the shorts used had been double heterozygotes in repulsion. In order to test this view, we have grown in 1948 fifteen progenies from shorts from these families crossed again with long. On the linkage hypothesis, the expectation is that about 1 in 15 of such parents should have received the mid gene and that it, unlike its short parent, should be a double heterozygote in coupling, giving approximately 14 *L* : 1 *M* : 15 *S*.

The results of 1948 have completely verified this supposition. Fourteen of the progenies grown have given long and short only, in all 723 long and 675 short, while the remaining progeny has given 17 *L* : 2 *M* : 38 *S*, practically in the proportions anticipated.

These experiments do not complete the demonstration that *Oxalis valdiviensis* is disomic, unlike *Lythrum salicaria*, which has been shown to be tetrasomic. Such a conclusion is suggested by Lady Barlow's earlier work[1,2], and critical tests have been prepared for next year. If, however, the species proves to be disomic, the population maintained by legitimate pollination would contain one genotype long, two mid, heterozygous and homozygous respectively for the mid gene, and four short, including the two double heterozygotes in coupling and repulsion. Plants homozygous for the short gene could not be produced by legitimate pollination. In *Lythrum salicaria*, on the other hand, there are one genotype long, four mid and ten short[3].

In any event, the fact that the two controlling factors are here linked shows that the genetic situation is quite distinct from that in *Lythrum*, in spite of the two remarkable similarities that in both species the double recessives are long-styled, and in both the factor for short-style is epistatic to that for mid.

A detailed note of these experiments will be published in *Heredity*.

R. A. Fisher
V. C. Martin

Department of Genetics,
University of Cambridge.
May 26.

[1] Barlow, N., *J. Genet.*, **3**, 53 (1913).
[2] Barlow, N., *J. Genet.*, **13**, 133 (1923).
[3] Fisher, R. A., and Martin, V. C., *Nature*, **160**, 541 (1947).

Microflora of the Rumen of the Sheep

In a previous communication[1], McGaughey and Sellers stated that sheep, with permanent rumen fistulæ, fed on hay and mangolds, develop a rumen microflora similar to that described by Quin[2] as occurring in sheep in South Africa. They pointed out that the organism found overwhelmingly predominant and apparently that termed *Schizo-saccharomyces ovis* by Quin is motile, and is apparently the same organism as that described by Woodcock and Lapage[3] and now known as *Selenomonas ruminantium* (Certes).

We believe that the organism is not a Schizosaccharomycete, as a result of (*a*) the study of its morphology, for example, characteristic wriggling motility, bean shape, pointed ends and absence of endospores; (*b*) failure to grow in media usually found to be adequate for the culture of Schizosaccharomycetes. Woodcock and Lapage[3] in their detailed examination of *Selenomonas ruminantium* did not overlook the possibility of it being a yeast; but after examination of authenticated strains of Schizosaccharomycetes, decided that they were not related. Moreover, they mentioned that Ledingham[4] was unable to cultivate *Selenomonas ruminantium* on various media; our attempts at cultivation have been equally unsuccessful. Thus, plating on potato dextrose agar of a centrifugate containing 10^{10} selenomonads per ml. yielded as the most numerous types of organisms: Rhodotorulæ 5×10^{6}/ml., *Aerobacter* 3×10^{6}/ml., yellow and white cocci 1×10^{6}/ml., Bacilli 1×10^{5}/ml., *Candida*-like organisms 1×10^{3} to 10^{5}/ml. After incubation of rumen contents mixed with dextrose solution, several other

types of yeasts were isolated; these have not been fully identified, but none is a Schizo-saccharomycete.

As it is possible that the growth of bacteria and yeasts may inhibit the growth of selenomonads, single-cell culture methods were adopted. By micro-manipulation, four different morphological stages of *Selenomonas ruminantium* were transferred to each of the following media: potato dextrose agar, the same with addition of 20 per cent dextrose, synthetic medium with 2 per cent and 20 per cent dextrose added, potato dextrose agar with rumen filtrate (1 : 1) added. No growth whatever occurred after these transfers; indeed, contact with these media inhibited motility at once.

In addition to the media mentioned above, many others, inoculated with fresh motile selenomonad suspension and incubated aerobically, anaerobically, in carbon dioxide atmospheres, at low temperatures and high temperatures have been used without success.

The inferences from our culture studies are (1) *Selenomonas ruminantium* did not grow; (2) if Schizo-saccharomycetes had been present, they would have been observed.

Hence we believe that the predominant organism of the rumen is not a Schizo-saccharomycete. Further, we have found no evidence of Schizo-saccharomycetes in the rumen of sheep in Great Britain. We suggest that the term *Schizo-saccharomyces ovis*, as applied to the organisms in question, is misleading and should be discontinued.

M. Ingram
Low Temperature Research Station,
Cambridge.

C. A. McGaughey
Institute of Animal Pathology,
Cambridge. May 25.

[1] McGaughey, C. A., and Sellers, K. C., *Nature*, **161**, 1014 (1948).
[2] Quin, J. I., *Onderstepoort J. Vet. Sci.*, **18**, 91 (1943).
[3] Woodcock, H. M., and Lapage, G., *Quart. J. Micr. Sci.*, **59**, 431 (1943).
[4] Lodingham, quoted by Woodcock and Lapage (see ref. 3).

British Folliculinidæ (Ciliata, Heterotricha)

Since February 1947, I have had the opportunity of making an intensive search for Folliculinids at Plymouth, where I found four species, and at Cullercoats where five species were discovered. Except for *Folliculina* (*Folliculinopsis ?*) *ampulla*, no record of Folliculinid species existed at these two marine laboratories. Besides the six species already recorded by me for Great Britain[1], a seventh species, *Folliculinopsis* (*Metafolliculina*) *andrewsi* (Hadzi), found by me both at Plymouth and at Cullercoats, should now be added to the list of British species.

The species recorded by me are: *F. producta*, *F. andrewsi*, *F. viridis* and *F. elegans* from Plymouth (list and specimens with Director, Plymouth Laboratory), and *F. producta*, *F. andrewsi*, *F. viridis*, *F. elegans* and *F. simplex* from Cullercoats (list with Director, Dove Laboratory). The only other records are *F. ampulla* and *F. elegans* from Port Erin (Bruce[2]), and a single species, *F. viridis*, from Swansea (Fowell[3]). The finding of *Folliculinopsis* (*Metafolliculina*) *andrewsi* (Hadzi) is the first record of the species on the east side of the Atlantic (the species being common around Woods Hole, United States), as well as a first record for Great Britain.

I shall be grateful for information regarding British records of other species of Folliculinidæ, which workers in marine laboratories may come across, to enable me to include it in the systematic account well under way for publication.

My thanks are due to Wing-Commander F. S. Russell for allowing me a table at Plymouth in September 1947, and to Prof. A. D. Hobson for facilities for work in the Marine Laboratory at Cullercoats during 1946–47.

S. M. Das
Department of Zoology,
University, Lucknow.
May 7.

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Number of Sperms Required for Fertilization

Much has been done in recent years to determine the number of sperms which must be introduced by artificial insemination to maintain a normal rate of fertilization. There are, however, markedly divergent views as to the number of sperms normally present in the immediate vicinity of the eggs at fertilization. Such direct evidence as exists suggests very small numbers. Thus Hammond[1] reports finding remarkably few in smears prepared from the fallopian tube of rabbits killed 10 hr. after coitus. Hammond and Walton[2] examined the ovarian capsules of ferrets at 3–36 hr. after coitus, and counted 1,600 sperms in one ferret and 0–75 sperms in six others. The number of sperms in the tubes of rats were observed by Blandau and Money[3] to increase during the hour after coitus to a maximum of about 200.

On the other hand, it is a widely held theory that the eggs of many species of mammals must be freed from the surrounding mass of follicle cells, by means of hyaluronidase, before sperm penetration can take place, and there is a strong implication that a large aggregation of sperms is necessary to assure an adequate concentration of hyaluronidase. Pincus and Enzmann[4] stated that at least 20,000 sperms/c.mm. are required for follicle cell dispersal and fertilization *in vitro*, and Pincus[5] suggests that this may also be the case *in vivo*. Kurzrok, Leonard and Conrad[6] concluded from their studies that an accumulation of about 20 million sperms would be needed in the vicinity of the human egg *in vivo*.

It has been shown, however, that in the rat denudation of the egg is not a prerequisite of fertilization[7,8]. This would appear to remove the principal reason for supposing that large numbers of sperms are necessarily involved at fertilization. Further information on this matter has now been obtained.

When rabbits are artificially inseminated with $0{\cdot}5–1{\cdot}0 \times 10^6$ sperms and killed 12–15 hr. later, the eggs are frequently recovered in apparently intact masses of cumulus cells. Nevertheless, a proportion of the eggs show evidence of sperm penetration, and at 15 hr. the pronuclei can be discerned by means of the phase-contrast microscope. This confirms the observations previously recorded for the rat.

Attempts were made to count the number of sperms in the washings from the tubes of rabbits inseminated with about $1{\cdot}0 \times 10^6$ sperms. Accurate assessment is very difficult owing to the relatively large volume of fluid required for thorough washing; but it was estimated that about 2,000–4,000 sperms were present throughout the length of a single tube. The number in the immediate vicinity of the eggs

must have been much smaller. Insemination with less than $1{\cdot}0 \times 10^6$ sperms, though resulting in the fertilization of a proportion of the eggs, greatly reduces the number of sperms in the tubal washings, so that even an approximate estimation was not found practicable.

Fertilization in the rat takes place in a distended portion of the fallopian tube, near the infundibulum. If the distension is incised the contents, including the cumulus masses, flow out freely, and it is likely that the special conditions prevailing permit the escape of the great majority of the sperms suspended in the fluid around the eggs. Systematic counts of sperms in this fluid and in the follicle cell-mass have been made in seven rats. The number of sperms varied from 9 to 101 in individual tubes, with a mean of 43.

Epididymal sperms were introduced into the fallopian tubes of rabbits 5–6 hr. before ovulation. Large numbers of sperms (about $2{\cdot}0 \times 10^6$) resulted in the fertilization of fourteen out of eighteen eggs (in four rabbits). With small numbers (1,140–1,600) four eggs were fertilized in a total of sixty-nine (in fourteen rabbits). This is a low rate of fertilization; but it should be noted that the dilutions to which the sperms were necessarily subjected (up to 1 : 2,000) had a deleterious effect upon them and about 50 per cent were immotile when introduced. Furthermore, in the 5–6 hr. before ovulation, considerable dispersion throughout the tube may have taken place, so that the number ultimately present at the site of fertilization must have been much less than the number introduced.

On the basis of these observations it is concluded that fertilization can take place when there are in the vicinity of the eggs less than a hundred sperms in the rat and less than a thousand in the rabbit.

My sincere thanks are due to the Medical Research Council and to Sir Charles Harington for the hospitality of the National Institute for Medical Research, and to Dr. A. S. Parkes for his invaluable criticism and advice.

C. R. AUSTIN

National Institute for Medical Research,
London, N.W.3.
July 28.

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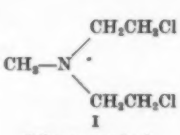
Inactivation of Complement by Nitrogen Mustard

THE recent clinical use of the nitrogen mustards for the treatment of Hodgkin's and other neoplastic diseases[1] has focused attention on these compounds and more particularly on their biological action. The intensive study of these vesicants made during the War[2], when they were regarded as potential chemical warfare agents, has been continued in the hope that more information will be gained about their action on animal tissues and about the basis of their therapeutic effect.

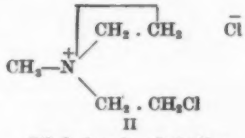
In some of our investigations we have studied the action of one of the most commonly used nitrogen mustards, methyl-*bis* (β-chloroethyl) amine (I), on complement, and have found that complement is rapidly destroyed or inactivated by the vesicant. This inactivation is similar in many respects to that effected by 'ordinary' mustard gas[3]. The amount of nitrogen mustard required completely to inactivate the hæmolytic complement of guinea pig serum at 37° is small, and the inactivation is not due to hydrochloric acid liberated by hydrolysis of the nitrogen mustard since the *p*H of the mixtures was maintained at about 7·5 throughout the reaction.

The addition of 2·5 mgm. of the nitrogen mustard hydrochloride to 0·50 ml. of guinea pig serum resulted in partial inactivation of the complement in 10 min. at 37° and complete inactivation in less than 30 min. Considerably smaller amounts of the nitrogen mustard can effect this inactivation; thus, 0·25 mgm. destroyed at least three-quarters, and 0·05 mgm. about half, of the complement activity of 0·50 ml. of guinea pig serum in 3 hr. and 6 hr. respectively at 37°. The inactivation, like that effected[3] by 'ordinary' mustard gas, ββ′-dichlorodiethyl sulphide, concerns all four components of complement, but the fourth component (that specifically inactivated by ammonia) appears to be less readily inactivated than are the others.

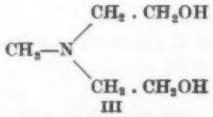
The nitrogen mustards quickly undergo chemical changes in solution[4,5], and the biological action of the parent substance appears to be due mainly to the capacity of some of these transformation products to react rapidly with certain tissue constituents. In aqueous solution methyl-*bis* (β-chloroethyl) amine (I) undergoes cyclization to form the corresponding very reactive imine (II); further cyclization and other changes follow more slowly, and the complete series of changes results in the production of several products, including methyl diethanolamine (III).



I
Nitrogen mustard
(Code No. HN2)



II
Ethylenimonium derivative
of I



III
Methyl diethanolamine

In some of our experiments, we have tested the complement-inactivating power of 'hydrolysed' nitrogen mustard, that is, solutions of the vesicant which have been kept at 37° for varying lengths of time before addition to guinea pig serum. These experiments have shown that previous hydrolysis of the vesicant greatly reduces its capacity to inactivate complement, and that solutions kept for 3 hr. at about *p*H 7·5 and at 37° have lost most of their inactivating power. Methyl diethanolamine (III) in amounts up to 125 mgm./0·5 ml. of guinea pig serum has no significant complement-inactivating action, and the slight inactivating power of hydrolysed nitrogen mustard is probably due to the presence of

a small amount of the original compound (I) in the solution, for it has been shown[4] that a 1 per cent solution of (I) kept at 25° for 70 hr. still contains about one-fifth of the unchanged compound. The toxic compounds formed from the nitrogen mustard in solution at *p*H 7·5 appear to differ from those which inactivate complement, for the activity of the former increases[6] as the solution is kept at 38° and *p*H 7·4 for 1–2 hr., whereas our experiments have shown that the complement-inactivating power decreases under these conditions.

The amount of nitrogen mustard we have used in our experiments is appreciably greater than that likely to be present in the blood after injection of the drug into patients suffering from Hodgkin's disease; but it is possible that the smaller amounts used therapeutically (for example, 0·1–0·2 mgm./kgm. injected daily for 4–6 days) may reduce the complement titre of the blood of the patients. We are therefore testing the serum of some of these treated patients and are carrying out similar tests on injected guinea pigs. A fuller account of these investigations will be given elsewhere.

We are indebted to the Medical Research Council for grants which have covered the expenses of this investigation.

W. M. Watkins
A. Wormall
Department of Chemistry and Biochemistry,
Medical College of St. Bartholomew's Hospital,
London, E.C.1.
May 12.

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Loss of White Cells in Bone Marrow Culture

Many techniques of cell culture involve suspension of cells in some fluid medium, and incubation in sterile glass containers, with subsequent counting of the suspended cells. Although it has long been known that certain cells are very 'sticky' and can adhere most firmly to glass surfaces[1], this fact seems to have been neglected in work with cell cultures, where some cells might be lost by irreversible adhesion to the walls of the culture vessel. The following is an attempt to investigate this point in bone-marrow culture; here adhesion is of particular importance because only certain types of hæmopoietic cells are 'sticky'.

The technique used has been previously described[2], and in essence consists of suspension and incubation of marrow cells in 80 per cent sterile serum. Comparison was made between cultures in ordinary clean glass bottles and cultures in bottles previously coated with silicone[3] to make the surface non-wettable

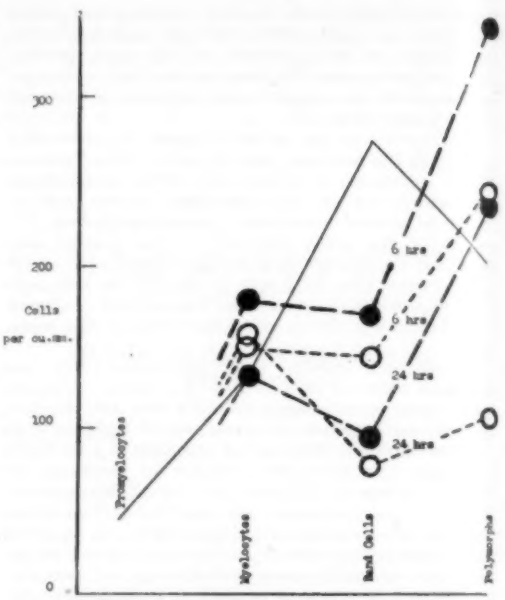

Fig. 1. Myeloid cell counts in marrow culture. Results after incubation for 6 and 24 hours in silicone-coated and plain glass bottles

and to prevent adhesion of cells. At all periods of incubation there was a consistently greater number of myeloid cells in the siliconed bottles, the difference being statistically significant and affecting myelocytes, band cells, and polymorphs; this difference was so great that, had silicone not been used, the increase in polymorphs due to maturation would have been missed (Fig. 1); lymphocytes and nucleated red cells showed no such effect. The loss of cells by adhesion amounted to about half a million in each bottle, and so was easily detected when the initial myeloid count was low (1,000,000 per bottle, or 500 per cub. mm.), but became statistically undetectable when the counts were higher (10,000,000 per bottle, or 5,000 per cub. mm.). This result is probably of some importance to those who are performing cultures with a low initial concentration of cells.

Previously it had been noticed that there was an apparent increase in myeloid cells in cultures, when

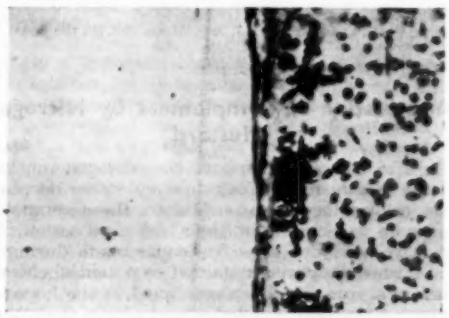

Fig. 2. Adhesion of leucocytes to glass coverslips (× 75). The left coverslip from a culture in heated serum; the right from a culture in unheated serum. Both after 48 hr.

the marrow specimens were suspended in reconstituted dried plasma or in serum which had been heated to 56° C. for one hour, instead of in unheated serum. As it is known that adhesion of leucocytes requires the presence of some thermolabile factor in serum[4], this effect was thought to be due to adhesion of the cells in unheated serum. To check this point, a grease-free coverslip was laid on the floor of each culture bottle, and was removed, washed in running tap water, and stained at the same time as the smears and total counts were made (that is, after 1–4 days). The photograph (Fig. 2) shows two such coverslips, the left from a 48-hour culture in heated serum, the right from a similar culture in unheated serum. The cells involved were always predominantly myeloid and monocytoid. No adhesion of nucleated red cells was ever seen. The density of the deposit was about 300,000 per square centimetre, this figure being of the same order of magnitude as that obtained from the silicone experiments.

H. J. F. Cairns
L. G. Lajtha

Department of Clinical Pathology,
Radcliffe Infirmary, Oxford.

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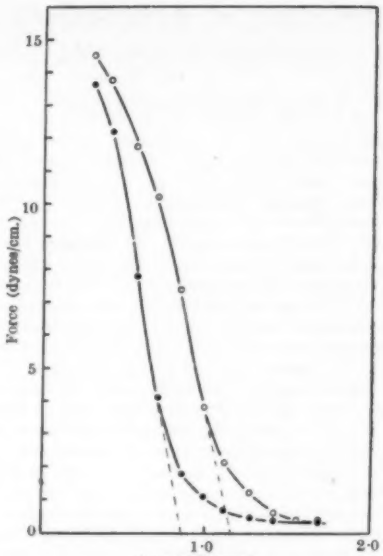
Effect of Adenosine Triphosphate on Monolayers of Myosin

Little is known about the behaviour of myosin in monomolecular layers. Communications previously published on this subject[1,2] appeared at an early stage of the study of myosin, that is, before Szent-Györgyi and his school[3] had shown that myosin consists of at least two different proteins, actin and myosin proper. In connexion with work in this laboratory[4] on the interaction between high-energy phosphate compounds and the different components of myosin, the investigations have been extended to monolayers of these proteins.

The influence of adenosine triphosphate and related substances on the force-area relationships of monolayers of actin-free myosin and the complex actomyosin has been studied. The proteins in question were isolated by Szent-Györgyi's method[5]. Actin was obtained in aqueous solution, actomyosin and myosin proper in salt solutions (0·6 *M* potassium chloride). The solutions were diluted to approximately 0·2 per cent (referred to dry-weight determinations) and roughly filtered before spreading.

Actin spreads on water or salt solutions, whereas actomyosin and actin-free myosin spread effectively only on solutions of considerable ionic strength. The most favourable conditions were provided by using a veronal buffer of *p*H 5·3, made 0·6 *M* with respect to potassium chloride, in all experiments.

Each film was allowed to spread for four minutes at zero pressure before readings were taken. Experimental data for a sample of actomyosin are recorded in the accompanying graph. When adenosine triphosphate is added to the substrate to a final concentration of 0·05 mgm./ml. (0·00005 *M*), the force-area curve for the monolayer is changed. The sudden increase in slope of the curve now occurs at a larger area than before. The effect of adenosine triphosphate is highly specific, as adenosine diphosphate, and inorganic tripolyphosphate, pyrophosphate and orthophosphate employed in the same molar concentrations have no visible effect. Only on addition of these substances in concentrations approximately ten times higher are similar effects obtained. Owing to the uncertainty in the dry-weight determinations, too much emphasis should not be laid on the absolute values of the area in the diagram.



Force-area curves for actomyosin
●—●—●, without adenosine triphosphate
○—○—○, 0·05 mgm. per ml. adenosine triphosphate

The data obtained in several experiments indicate that the expanding effect is more pronounced with monolayers of myosin proper than with those of actomyosin. In the latter the area at zero compression increases after addition of adenosine triphosphate by about 30 per cent, whereas in the case of myosin proper the average increase amounts to 100 per cent. In both cases the gradient of the approximately rectilinear part of the curve decreases when adenosine triphosphate is added. Actin shows no reaction with adenosine triphosphate or the other phosphate compounds investigated.

The result indicates that adenosine triphosphate in some way combines with myosin and causes it to expand, thereby increasing the surface pressure of the monolayers in the condensed state. According to a verbal communication from Dr. D. F. Cheesman, it is probable that the effects described above may be due rather to the spreading kinetics of myosin than to the properties of the fully spread films.

My thanks are due to Prof. E. K. Rideal and Dr. D. F. Cheesman, of the Davy Faraday Laboratory at the Royal Institution, London, for hospitality and valuable advice. The preliminary experiments of the investigation were made in that Laboratory.

Agnete Munch-Petersen

Institute of Neurophysiology,
University of Copenhagen.
May 12.

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PARAMAGNETIC RESONANCE IN COPPER SULPHATE

Experimental Investigation

INVESTIGATIONS of paramagnetic resonance in salts of the iron group of transition elements at centimetre wave-lengths have shown that it is possible to obtain detailed information about the lowest energy-levels of the paramagnetic ion by these methods[1]. We have investigated at room temperature the resonance absorption in single crystals of copper sulphate ($CuSO_4.5H_2O$) at wave-lengths of 3·04 cm., 1·23 cm. and 0·85 cm. in a magnetic field. The results show two features of considerable interest: first, that under certain conditions the absorption line is very much narrower than would be expected from the normal magnetic interaction of the ions; and secondly, that at the longer wave-lengths only one line is found, whereas theoretically two lines should appear at certain orientations of the crystal in the external magnetic field. In fact, it is only at 0·85 cm. wave-length that the two lines are just resolved.

The measurements are made by placing a section of a single crystal at the bottom of a cylindrical H_1 resonator placed in a magnetic field at right angles to the high-frequency magnetic field. The magnification factor Q of the resonator is then measured for various values of the magnetic field.

Crystallographic data[2] show that there are two non-equivalent cupric ions in the unit cell, each surrounded by four water molecules and two oxygen atoms, in a nearly octahedral arrangement. The crystalline electric field acting on an ion is mainly of cubic symmetry with a component of tetragonal symmetry, the tetragonal axis being in the direction of the oxygen atoms and the angle between the tetragonal axes of the two ions being about 80°.

On this basis Polder[3] has calculated the energy-levels of the basic spin doublet in a magnetic field and hence the susceptibility of the salt, and these calculations are in good agreement with Krishnan's experimental work[4] on the susceptibility. The energy difference between the two spin-levels in a magnetic field H may be expressed as $g\beta H$, where β is the Bohr magneton and g depends on the orientation of the tetragonal axis with respect to the magnetic field. Thus the resonance absorption should occur when $g\beta H = h\nu$. Some of the experimental results are given in the accompanying table.

Direction of H	L_1 (154°, 64°, 51°)			L_2 (78°, 130°, 52°)				L_3		
Wave-length (cm.)	3·04	1·23	0·85	3·04	1·23	0·85		3·04	1·23	0·85
H at resonance Kg	3·36	8·36	12·1	3·11	7·76	10·6	11·9	3·10	7·75	11·2
g	2·09	2·08	2·08	2·26	2·26	2·37	2·12	2·27	2·26	2·26
g (susceptibility)	2·06	2·06	2·06	2·27	2·27	2·47	2·06	2·27	2·27	2·27
Width $\Delta H_{1/2}$ gauss	28	24	25	115	640		≃ 450	58	50	—

The orientation of the external magnetic field with respect to the crystallographic axes is denoted by L_1, L_2 and L_3. L_1 is the direction at right angles to the tetragonal axes of both ions, L_2 is along one of the tetragonal axes and L_3 is a bisector of the angle between the two axes. (The angles which L_1 and L_2 make with the crystallographic axes are also given.)

The main features of the results may be summarized as follows. (1) The g values are in good agreement with those obtained from susceptibility measurements, but theoretically there should be two lines when H is along L_2. In this case H is nearly at right angles to the tetragonal axis of one copper ion, which should therefore have the same g value as when H is along L_1 (that is, 2·06). The g value of the other ion should be 18 per cent higher, the mean value of the two ions being equal to that given by the susceptibility measurements. That the appearance of only one line is not due to lack of resolution is shown by the fact that at 3·04 cm. the two lines should be about 500 gauss apart, whereas the width ($\Delta H_{1/2}$) of the line is only 115 gauss. At 0·85 cm. wave-length, however, the two lines are just resolved.

(2) The width $\Delta H_{1/2}$ given here is the difference in magnetic field between the position of maximum absorption and that at which the absorption is half its maximum value. This width varies very greatly both with orientation and with wave-length. One cause of broadening of the line is the fluctuating magnetic field due to neighbouring dipoles. The effective internal field due to this is about 370 gauss in copper sulphate, and therefore the width of the line should be of this order, whereas for H along L_1 the width is only 25 gauss.

Van Vleck and Gorter[5] have suggested that this narrowing of the line may be due to the effect of exchange forces between the copper ions, and a qualitative description of the other results may be given on this basis as follows. When H is along the tetragonal axis of one of the copper ions, the values of g, and therefore the precessional frequencies of the two ions, are different. If there is exchange between the ions, the type of absorption curve obtained will depend on whether the exchange frequency is greater or smaller than the difference in the precessional frequencies. When it is larger, a mean value of the energy of the two copper ions should be measured, whereas when it is smaller each ion should be observed separately and two lines should appear. A rough estimate of the exchange frequency can be made from the fact that at 1·23 cm. the two lines are just not resolved. The difference in frequency of the two lines at constant H would be about 0·15 cm.$^{-1}$, which is therefore the order of the exchange frequency.

On this theory the maximum width should occur when the difference between the values of g of the two ions is a maximum, that is, with H very nearly parallel to one of the tetragonal axes, and this is found experimentally. Also the minimum width should be when the two values of g are equal, for example, in the plane containing L_1 and L_3. This is also found experimentally, although the width is not constant in this plane, varying from 25 gauss along L_1 to 60 gauss along L_3. A quantitative theory of the broadening due to exchange of dissimilar ions is given in the following communication by Prof. M. H. L. Pryce.

The behaviour of copper sulphate crystals may be contrasted with that of potassium – copper sulphate ($CuSO_4.K_2SO_4.6H_2O$), in which two lines are observed[6] when H is in the appropriate direction, the values of g being in close agreement with theory. The exchange frequency in this salt is therefore very considerably smaller.

It might be expected that there would be some connexion between the exchange energy measured in this way and the specific heat anomaly found in copper sulphate crystals at about 1° K. but not found in the potassium–copper salt[7]. The order of magnitude of the exchange energy is some five times too small, but presumably exchange between like ions should contribute to the specific heat, whereas only the

exchange between dissimilar ions is effective in the problem discussed here.

Details of these measurements will be published in the near future.

D. M. S. Bagguley
J. H. E. Griffiths

Clarendon Laboratory,
Oxford.
July 26.

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Theory

In many paramagnetic crystals the resonance absorption of microwaves in the presence of a transverse magnetic field spreads over a range of a few hundred gauss, and this can be accounted for by the magnetic interaction between the ions. There are certain substances, however, of which copper sulphate is an example, in which the resonance is sharper than can be explained in this way, and it has been suggested that the sharpness is due to electron exchange[1]. Gorter and Van Vleck[2] have reported the result of a calculation which shows that, while the mean square spread is unaffected by exchange, the mean fourth power spread is increased, indicating a sharpening of the peak together with an enhanced absorption in the wings of the resonance. That such an effect is to be expected can be seen from the following qualitative argument.

The effect of exchange can be described as an interchange of the spins of the ions with a frequency spectrum determined by the magnitude of the exchange energy. If this frequency is high compared with the spread of precession frequencies of the ions in the applied magnetic field, due to the random orientation of the magnetic field of neighbouring ions (the internal field), the latter will fluctuate so rapidly that only an average value will be effective. The statistical weight of states in which the average is comparable to the instantaneous internal field is relatively small, and the net effect will be to reduce the breadth of the resonance. The effect is similar to the sharpening of nuclear paramagnetic resonances in liquids due to the rapid molecular motions[3].

The observations on copper sulphate[4] are consistent with the hypothesis that the breadth due to magnetic interaction, reduced by exchange in this way, is only about 25 gauss; but that there is, in addition, a broadening caused by the exchange of electrons of cupric ions having different principal magnetic axes, and that this is the main cause of broadening of the resonance, except for certain orientations of the applied field.

There are two non-equivalent sets of cupric ions in hydrated copper sulphate ($CuSO_4.5H_2O$), distinguished by different orientations of the neighbouring oxygen atoms and water molecules. Polder[5] has shown that the magnetic behaviour is well accounted for by the action on the cupric ions of a crystalline field composed of a part with cubic symmetry and one with tetragonal symmetry. Each ion (spin $\frac{1}{2}$), in its ground state, is magnetically uniaxial. In susceptibility measurements copper sulphate is anisotropic with three principal axes as follows: (1) along the direction perpendicular to the principal axes of the two types of ion; (2) and (3) along the bisectors of the angles between them. There is, however, a slight discrepancy between the calculated susceptibilities and the observations of Krishnan and Mookherji[4], which may indicate that a single ion is not exactly uniaxial.

In view of the smallness of the magnetic broadening, it is reasonable to attempt a calculation of the broadening in which only the exchange effect is considered, and the magnetic interaction is ignored. The exchange energy will be assumed to be of the usual 'isotropic' type and not of the 'anisotropic indirect' type discussed in a recent paper by Opechowski[7]. Had the ions all been equivalent, the exchange would have caused no broadening. One may therefore try to treat the slight difference between the ions as a perturbation, and expect reasonably correct results provided the difference in magnetic energy of the two kinds of ions, when they have the same spin orientation, is small compared with the exchange energy. This condition is equivalent to saying that the frequency must be small compared with the frequency at which the absorption curve first shows two resolved peaks, corresponding to the different effective moments of the two kinds of ion: this frequency is about 1 cm.$^{-1}$ for copper sulphate. Alternatively, for higher frequencies, one may treat the exchange interaction as a perturbation. The experimental material available at present refers more nearly to the former condition, and the present note deals only with results calculated on this approximation.

The magnetic energy of a single ion in a magnetic field $\mathbf{H}$ can be written

$$E_{\text{magn}} = \mu \mathbf{s}.\mathbf{g}.\mathbf{H},$$

where $\mathbf{s}$ is the spin angular momentum divided by $\hbar$, $\mathbf{g}$ is a tensor the principal values of which are the g-values in the principal directions of the ion and μ is the Bohr magneton. For the spin system in a crystal, the total energy can be written

$$\begin{aligned} E &= \mu\, \mathbf{S}'.\mathbf{g}'.\mathbf{H} + \mu\, \mathbf{S}''\mathbf{g}''\mathbf{H} + E_{\text{ex}} \\ &= \tfrac{1}{2}\mu(\mathbf{S}' + \mathbf{S}'').(\mathbf{g}' + \mathbf{g}'').\mathbf{H} + E_{\text{ex}} + \\ &\qquad \tfrac{1}{2}\mu\,(\mathbf{S}' - \mathbf{S}'').(\mathbf{g}' - \mathbf{g}'').\mathbf{H}, \qquad (1) \end{aligned}$$

where $\mathbf{S}$ refers to the total spin of ions of one type, and the superscripts $'$ and $''$ refer to the two types of ion. E_{ex} is the exchange energy of the system. The third term in (1) is treated as a small perturbation.

If the third term were absent, the energy would be the sum of two commuting parts, and the eigenvalues would be the sum of the eigenvalues of the parts. An oscillating transverse field would cause transitions between states the spin of which in the direction of $(\mathbf{g}' + \mathbf{g}'').\mathbf{H}$ differs by one unit, and which have the same value of the exchange energy. The system would have a single sharp absorption frequency

$$\mu\,|\,(\mathbf{g}' + \mathbf{g}'').\mathbf{H}\,|\,/2\hbar.$$

The effect of the perturbation term, which expresses the difference between the ions, is threefold:

(*a*) It changes the energy-levels of the system, and hence the energy difference of levels connected by the above selection rule. The absorption now takes place over a range of frequencies (for a fixed magnetic field, or conversely, for a fixed frequency, over a range of magnetic field). This is the main effect. The shape of the line from this cause may be expected to be roughly a Gaussian curve.

(*b*) It introduces into the eigenfunctions admixtures of wave functions belonging to other eigenvalues of the exchange energy, thereby allowing weak transitions to states excluded by the original selection rule. This is most marked for states differing only slightly in exchange energy, and gives rise to a 'tail' on the absorption curve, falling off roughly inversely as the square of the distance from resonance. It may also give rise to enhanced absorption at low frequencies and at twice the resonant frequency. This effect increases with magnetic field.

(*c*) The coupling with the oscillating field being unsymmetrical with respect to the variables of the two types of ion, transitions can be induced to states of different exchange energy. This effect is similar to (*b*), except that it shows no marked preference for small differences of exchange energy and is roughly independent of H. It gives a background of non-resonant absorption.

A straightforward application of second-order perturbation methods (the first-order effect is zero) leads to the following expression for the dependence of effect (*a*) on orientation and frequency. Using a notation in which l_1, l_2, l_3 are the cosines of the angles between the magnetic field and the principal magnetic axes, and g_1, g_2, g_3 are the principal g-values, the breadth ΔH_{ex} due to exchange, for fixed frequency ν, is given by

$$\Delta H_{ex} = \frac{C\nu^2\left[\begin{array}{l}4(g_1+g_2)^4 l_1^4 l_2^4 \\ -4A(\nu)\{(g_1+g_2)^2 l_1^2 l_2^2 + g_1 l_1^2(l_2^2+l_3^2)+(g_2 l_2^2 - g_3 l_3^2)^2\} \\ +B(\nu)\{g_1^2 l_1^2(l_2^2+l_3^2)+(g_2 l_2^2-g_3 l_3^2)^2\}^2\end{array}\right]^{1/2}}{[g_1^2 l_1^2 + g_2^2 l_2^2 + g_3^2 l_3^2]^{5/2}} \qquad (2)$$

where C is a constant depending on the magnitude of the exchange energy but independent of orientation, temperature and frequency, and $A(\nu)$, $B(\nu)$ are independent of angle and temperature, and tend to 1 in the limit of low frequencies (small compared with the exchange frequency, that is, about 0·15 cm.$^{-1}$).

The breadth is to be interpreted as a root mean square deviation from the centre of resonance. In comparing with experiment it should be noted that it refers to the Gaussian part of the peak and ignores the tail. The formula will vary in a more complicated manner with orientation if the individual ions are not uniaxial, but will involve the frequency in the same way.

If one wishes to include the effect of magnetic interaction one may, as a rough estimate, make the assumption that the square of the total breadth is the sum of squares of partial breadths

$$(\Delta H)^2 = (\Delta H_{ex})^2 + (\Delta H_{magn})^2$$

and suppose that ΔH_{magn} is not very sensitive to orientation.

It is to be emphasized that (2) is valid only for frequencies small compared with 1 cm.$^{-1}$, and provided $\mu H \ll kT$.

M. H. L. Pryce

Clarendon Laboratory, Oxford.
July 26.

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ROYAL OBSERVATORY, GREENWICH

THE Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read on the occasion of the annual visitation of the Observatory on June 5, covers the period May 1, 1947–April 30, 1948, and the state of the Observatory mentioned in various parts refers to the latter date. Although a large amount of the report deals with the usual routine work, certain portions are concerned with the grave difficulties that have arisen in the post-war period, which may not be completely overcome for several years. This short synopsis of the report will deal chiefly with these difficulties.

Stage I, as it is called, of the move to Herstmonceux was arranged to take place in August and was intended to include the Nautical Almanac Office, the Chronometer Depot, the Magnetic and Meteorological Department, and the secretariat; the Solar Department will wait until the new Solar Building is ready. Even under normal conditions, the removal would have entailed considerable disorganisation to the work of the Observatory; but this disorganisation is greatly increased by the difficulties in the present conditions. No provision has been made in the estimates for the current financial year for the completion of Stage I of the move, and the output of the Observatory is necessarily curtailed with every month of delay. As might be expected, some of the instruments are not in use, and there has been great disappointment regarding the performance of one in particular, about which something will be said later.

The 28-in. and 26-in. domes are in a bad state of repair, and it is doubtful whether either is suitable for transfer to Herstmonceux; until this point has been settled, no work on them will be undertaken. The 28-in. and 26-in. telescopes were dismounted in the autumn of 1947, and the former, with the exception of the lens and some minor parts, was transported by road to Herstmonceux, where it is stored in a brick hut. The necessary parts of the drive have been sent to Sir Howard Grubb, Parsons and Co. for alteration to a synchronous motor drive. Practically all the 26-in. telescope has been sent to the same firm, as it was decided that roller bearings in both axes should be inserted. The objectives of these telescopes are still in good condition and remain for the present at Greenwich.

The mirrors of the 36-in. Yapp reflector were aluminized in May 1946; but the instrument remained unused until November. In December the 36-in. mirror was given a light alcohol wash and was then found to be in poor condition. It was used until March 1948, when it was discovered that several areas each about two inches across had lost all their coating, and after a fresh wash, the reflexion coefficient was estimated to be as low as about 30 per cent. The mirror was cleaned and silvered; but surface blemishes remained visible on the glass even after silvering and it is not certain how much of this can be attributed to poor aluminizing and how much to the deposit of chemically active dirt. It is interesting to know that the Cassegrain mirror was, and still is, in good condition, and the contrast between the two mirrors confirms what has been already known from other pairs of aluminized mirrors, one

facing up and one down, in the conditions which prevail at Greenwich. The expense and delay involved in sending the mirror away to be aluminized are not warranted while the mirror remains at Greenwich; but as the spectrograph is primarily for use in the ultra-violet region, the effectiveness of the telescope is very much reduced. When an aluminizing plant capable of handling the 36-in. reflector is installed at Herstmonceux, this state of affairs will be remedied, and this is just one among many reasons for accelerating the move to Herstmonceux.

If there be any who expect a greatly increased output from the Observatory in the near future, they will be disillusioned when they read the present report. It is emphasized that the situation which will prevail from the end of Stage 1 until completion of the move will be very disadvantageous in many ways, not least of which will be the marked excess of observers over instruments at Herstmonceux and Abinger. Many valuable years of potential training have been lost already; old observers are retiring and a new and inexperienced staff is increasing. Even if the dismemberment of the Greenwich Observatory could be effected immediately, much ground would have to be made up, and the longer the delay in unification the more serious will be the effects on the standards of observational skill. This is a matter which requires immediate consideration from the authorities, and another matter is of equal or even greater urgency.

While the hostel arrangements will cater reasonably well for the unmarried staff, no arrangements have yet been made for married men. It is almost certain that most married members of the staff, some of whom have had as much as six years war experience, will be faced with a period of at least a year's separation from their families. The continuance of a similar situation through all the later stages of the move must cause grave dissatisfaction and discouragement, and would have an adverse effect on the smooth running of the Observatory. The Astronomer Royal has proposed to the Admiralty that houses should be provided for the senior observing staff, and the necessity for such accommodation, which is fairly normal for observatories, is obvious to everyone who knows that the Observatory at Herstmonceux is in an isolated area. Such provision on the edge of the Observatory property would greatly facilitate the night duties of the observing staff and also reduce the loss of observing hours. It is pointed out that it may be difficult to fill the additional vacancies for senior scientific workers which will occur later, because it is highly probable that many married men will refuse an offer which implies separation from their families. In the words of the Astronomer Royal: "There is evidently a grave risk that the increase in complement, which has been approved in principle, may be nullified in practice through an unrealistic approach to the housing problem, quite apart from the general hardship which is, as yet, the only prospect for existing married staff of the later stages".

The report devotes a little more than a page to the Isaac Newton Observatory which will be erected in the grounds at Herstmonceux. Among the types of observation to be undertaken with the 100-in. telescope are the following: stellar spectroscopy and spectrophotometry, star counts, galactic structure, the investigation of the distribution and extent of obscuring material, spectral classification with a slitless telescope, the determination of radial velocities, and observations of extra-galactic nebulæ. Details regarding optical design are still under consideration, and information will be obtained about the system of control which has been developed for the 200-in. telescope, and also on the methods of driving and control of other large telescopes. Messrs. Pilkington Bros., Ltd., have carried out investigations on the manufacture of large glass mirror disks, and it is proposed to make the 100-in. disk of 'Pyrex' glass and to cast it as a solid disk, the lower face being given a concave curvature of approximately the required amount. It is expected that the casting will be undertaken about March 1949.

The magnetic elements as determined at Abinger for 1947 and also the three preceding years are as follows:

Year	Declination (West)	Horizontal intensity	Vertical intensity	Inclination
1944	10° 07·8′	0·18566	0·43189	66° 44·3′
1945	9 59·5	0·18573	0·43207	66 44·3
1946	9 51·1	0·18569	0·43235	66 45·4
1947	9 43·1	0·18577	0·43246	66 45·2

At the time of writing the above summary of the Astronomer Royal's Report, it was known that there had been a delay in carrying out Stage 1 of the movement to Herstmonceux.

RESISTANCE TO SULPHADIAZINE AND 'PALUDRINE' IN THE MALARIA PARASITE OF THE FOWL (*P. gallinaceum*)

By Dr. ANN BISHOP
AND
ELSPETH W. McCONNACHIE
Molteno Institute, University of Cambridge

Acquired Resistance to Sulphadiazine

RECENTLY Bishop and Birkett[1], and Williamson, Bertram and Lourie[2], working independently, have described the development of resistance to the antimalarial drug 'Paludrine' in infections of *Plasmodium gallinaceum* in young chicks. This resistance developed rapidly and increased forty-fold within about four and a half months. With sulphadiazine and quinine, however, Williamson and his co-workers obtained no acquired resistance in *P. gallinaceum*, though the periods of drug treatment extended over two and a half years. Since the publication of their results, Knoppers[3] has described a twofold increase in resistance to quinine in the same species of avian malaria. Bishop and Birkett[4] found that resistance to sulphadiazine could be produced in *P. gallinaceum* in young chicks by methods similar to those with which they had induced resistance to 'Paludrine', though its development was relatively slow and the degree of resistance obtained was not great.

As a result of further treatment with gradually increasing doses of sulphadiazine, we have now obtained a strain of *P. gallinaceum* in young chicks in which the resistance to the drug is thirty-two times greater than that of the untreated strain. Whereas the minimum dose of drug which produces an adverse effect upon the growth-rate of the normal strain, when given twice daily on successive days, is 0·625 mgm./20 gm. of body-weight, in the resistant strain growth of the parasites occurs in birds receiving

20 mgm. twice daily*. It took approximately twelve months to produce this thirty-two-fold resistance to sulphadiazine. The degree of resistance acquired has been assessed at intervals, by comparing the intensities of infections produced by standard inocula (that is, 50,000,000 parasites per chick intravenously) of (*a*), the resistant strain, into groups of chicks receiving doses ranging from 2·5 to 20 mgm. of sulphadiazine twice daily for three-and-a-half days, and (*b*), the normal parent strain, into groups of chicks receiving similar drug treatment. The sulphadiazine-resistant strain produced infections in chicks receiving doses of drug which inhibited the development of the normal strain (that is, 2·5–20 mgm.); but the resulting infections were not as heavy as those produced by the parent strain in untreated birds. The sulphadiazine-resistant strain produced, on the whole, less intense infections in untreated birds than did the parent strain.

In the sulphadiazine-resistant strain of *P. gallinaceum*, exoerythrocytic schizonts were found in chicks during treatment with this drug.

We have proved that this sulphadiazine-resistant strain of *P. gallinaceum* is also resistant to sulphathiazole, sulphanilamide and sulphapyridine.

Bishop and Birkett[1,4] found that in *P. gallinaceum* resistance to 'Paludrine' was retained after five passages through mosquitoes without intervening drug treatment. On two different occasions *P. gallinaceum*, resistant to twice-daily doses of 5 mgm. of sulphadiazine, was passaged through *Aëdes ægypti* and afterwards tested, without intervening drug treatment, by the method outlined above: no loss in drug-resistance was observed. Williamson and his co-workers also observed no loss in resistance to 'Paludrine' after one mosquito passage; but, according to Knoppers[3], acquired resistance to quinine, in the same species of avian malaria, was partially lost after one mosquito-passage.

Experiments by Emerson and Cushing[5] upon acquired resistance to sulphonamides in *Neurospora* suggest a possible explanation of the discrepancy between the results of experiments upon the effect of mosquito transmission. In this organism, as in *P. gallinaceum*, resistance to sulphonamides arises by successive stages. In *Neurospora* the first adaptations to the drug do not involve a genetic change; but gene mutation appears later, after further drug treatment, in the more fully adapted strain. The resistance to quinine described by Knoppers was comparatively slight, being only twofold. In the light of Emerson and Cushing's observations, it is possible that this resistance might be due only partially to gene mutation, and that the degree of drug adaptation not genetically controlled might be lost during development in the mosquito in the absence of the drug. In strains of *P. gallinaceum* in which drug adaptation is more complete, for example, the 'Paludrine'- and sulphadiazine-resistant strains, the drug-resistance may be due wholly to the selection of drug-resistant mutants, with the result that no loss in resistance occurs during the sexual cycle in the mosquito.

Cross-resistance to Sulphadiazine and 'Paludrine'

The work of Bishop and Birkett[1,4], Williamson, Bertram and Lourie[2], and Williamson and Lourie[6] has shown that 'Paludrine'-resistant strains of *P. gallinaceum* are normally sensitive to quinine, 'Pamaquin' and 'Mepacrine', but resistant to the methyl homologue of 'Paludrine', *N′-p*-chlorophenyl-N⁵-methyl-N⁵-*iso*propylbiguanide. Williamson and his co-workers found that acquired resistance to 'Paludrine' did not confer resistance to sulphadiazine or to pyrimidine precursors of 'Paludrine' (for example, 3349, 2-*p*-chlorophenylguanidino-4-β-diethylaminoethylamino-6-methyl-pyrimidine), and they failed to produce strains of *P. gallinaceum* resistant to 3349.

The sulphadiazine-resistant strain of *P. gallinaceum*, when tested by the method described above, was found to be resistant to 0·1 mgm. of 'Paludrine' (the minimum dose which, when given twice daily, will suppress an infection of the normal strain of *P. gallinaceum*) although it had not been subjected to treatment with that drug.

Further tests for resistance to 'Paludrine' were made with two sulphadiazine-resistant strains of *P. gallinaceum* of more recent origin. These strains, *strain A* and *strain B*, had been isolated eleven weeks previously from the normal untreated parent strain, which was tested simultaneously for resistance to 'Paludrine' and found to be normally sensitive to the minimum effective dose (0·1 mgm.). *Strain A* was passaged twenty-two times during eleven weeks through birds receiving doses of sulphadiazine gradually increasing from 0·625 mgm. to 5 mgm. This treatment was similar to that by which resistance had been induced in the original sulphadiazine-resistant strain. *Strain A* was then tested and proved to be resistant, not only to 1·25 mgm. and, to a lesser extent, 5 mgm. doses of sulphadiazine, but also to 0·1 mgm. and 0·5 mgm. doses of 'Paludrine'.

Strain B, of identical origin to *strain A*, was treated with 5 mgm. doses of sulphadiazine for the eleven-week period. Whereas in *strain A* the infection in the passage birds was acute throughout the whole period of drug treatment, in *strain B* it was allowed to become chronic, passage into new chicks being performed only four times during the eleven weeks. The method by which the strains were maintained in the chicks did not, however, appear to be significant in the development of 'Paludrine'-resistance, as *strain B*, when tested simultaneously with *strain A*, against 0·1 and 0·5 mgm. doses of 'Paludrine', also proved to have become resistant to this drug. Though their reaction to 'Paludrine' was similar, these two strains differed in the degree of resistance to sulphadiazine which they had acquired. Whereas *strain B* was definitely resistant to 1·25 mgm. of this drug, it showed much less resistance to 5 mgm. doses than did *strain A*; but after further treatment with 5 mgm. doses of sulphadiazine, *strain B* acquired a resistance to this dose comparable to that of *strain A*. As yet, these strains have not been tested for resistance to 'Paludrine' in doses greater than 0·5 mgm.

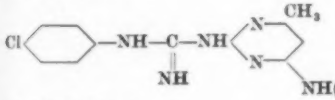
As acquired resistance to sulphadiazine was found to confer resistance to 'Paludrine', the effect of sulphadiazine upon a 'Paludrine'-resistant strain of *P. gallinaceum* was studied. This strain had been in contact with 'Paludrine' for more than eighteen months and had been passaged at frequent intervals, for more than twelve months, through chicks receiving the maximum tolerated dose (1·0 mgm. twice daily) almost daily throughout this period. When tested with doses of 1·25 mgm. of sulphadiazine, it was found to be resistant to this drug also. Whether this 'Paludrine'-resistant strain is resistant to higher doses of sulphadiazine has not yet been ascertained.

As the sensitivity of the 'Paludrine'-resistant strain to sulphadiazine had not been tested previously, it is

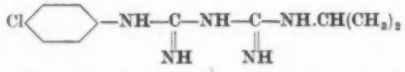
* Throughout this account, the doses of drug are expressed in mgm./20 gm. of body-weight of chick. The doses were given twice daily. The chicks used were four to fourteen days old at the beginning of treatment.

not known whether resistance to both drugs developed simultaneously, as in the case of the sulphadiazine-resistant strains *A* and *B*, or whether resistance to sulphadiazine developed only after prolonged treatment with 'Paludrine'. That the latter alternative is the more probable is shown by the following observations. The untreated parent strain of *P. gallinaceum* was tested with 1·25 mgm. doses of sulphadiazine and found to have a normal sensitivity to this compound. A substrain was then passaged at intervals of two to three days through chicks treated with doses of 'Paludrine' increasing from 0·025 to 0·2 mgm. After ten weeks treatment the strain was proved to be resistant to 0·5 mgm. doses of 'Paludrine', a dose greater than that with which it had been treated previously, but its sensitivity to the minimum effective dose of sulphadiazine was unchanged. In this strain, therefore, the development of resistance to 'Paludrine' was not accompanied by resistance to sulphadiazine. The strain is being treated further with larger doses of 'Paludrine' in order to discover if, and when, sulphadiazine-resistance develops. The fact that sulphadiazine-resistance did not develop simultaneously with resistance to 'Paludrine' in 'Paludrine'-treated birds, but only appeared in a strain subjected to prolonged treatment with the maximum tolerated dose of 'Paludrine', would explain the failure of Williamson and his co-workers[3,6] to observe resistance to sulphadiazine when their 'Paludrine'-resistant strain was treated with this drug, as their strain had been subjected to 'Paludrine' for a much shorter period than had ours.

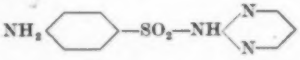
Williamson and his co-workers[2] suggest that the presence or absence of a pyrimidine ring in such compounds as 3349



and 'Paludrine'



may be a factor in determining drug-resistance. Sulphadiazine,



however, also contains a pyrimidine ring, and we have now shown that it, like 'Paludrine', forms drug-resistant strains of *P. gallinaceum* and that resistance between it and 'Paludrine' is reciprocal. On the other hand, Williamson and his co-workers[2] failed to produce resistance to 3349, which has a pyrimidine ring. In these compounds, therefore, the presence or absence of the pyrimidine ring does not appear to determine the formation of drug-resistant strains of *P. gallinaceum*.

It has been shown by Maier and Riley[7] in *P. gallinaceum* and by Marshall and his co-workers[8] in *P. lophuræ* that the antimalarial action of sulphonamides is inhibited by *para*-aminobenzoic acid. We have confirmed this observation on our strain of *P. gallinaceum*; but preliminary experiments suggest that the action of 'Paludrine' is not antagonized by this compound. The demonstration of cross-resistance between 'Paludrine' and sulphadiazine, two compounds of great importance therapeutically, presents a very interesting problem regarding the mechanism of their antimalarial action.

The work has been financed by the Medical Research Council. We are indebted to the Imperial Chemical (Pharmaceuticals), Ltd., for the 'Paludrine' and to Messrs. May and Baker, Ltd., for the sulphonamides.

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CHANGING ASPECTS OF NUTRITION

SECTION I (Physiology) of the British Association devoted the morning session on September 9 to a discussion of "The Changing Aspects of Nutrition". Prof. J. R. Marrack introduced the subject with a review of work done on the relation of nutrition to infection. He pointed out that we are uncertain which nutrients are particularly involved in defence against infection and how the defences are weakened by malnutrition, particularly in human beings. In experimental animals deprived of vitamin A the ciliated columnar epithelium of the respiratory passages undergoes keratinizing metaplasia. Bacteria that get into the passages are not cleared out by cilia, and the passages are blocked by desquamated cells. In consequence the animals are liable to get broncho-pneumonia. It is not known how frequently this keratinizing metaplasia occurs in the respiratory passages of human beings. When it is found, the nutritionist ascribes it to lack of vitamin A, whereas the morbid anatomist thinks that it is caused by inflammation or irritation.

In the discussion, Dr. H. M. Sinclair said that he had seen bronchiectasis in Holland, which was attributed to lack of vitamin A. In experiments in which human beings have been deprived of vitamin A for more than a year, the subjects were not abnormally liable to respiratory infections; nor do large supplements of vitamin A appear to reduce the frequency or severity of colds.

Cannon and his school have found that the formation of antibodies is impaired in animals that are severely depleted of protein. Gell has recently shown that very ill-nourished Germans formed less antibodies in response to injections of antigens than were formed by well-fed British soldiers. But protein is not the only nutrient that is involved in the formation of antibodies, and other defences are impaired in malnourished animals.

Prof. Marrack suggested that the infecting organisms of those diseases, to which resistance seems to be increased by malnutrition, are exacting organisms that invade the cells of the host. When the host lacks some nutrient, such as vitamin B_1, the metabolism of the host's cells may be so altered that they are no longer congenial to the invader.

Dr. J. W. Howie described experiments designed to show the effects of the less-severe degrees of malnutrition. The number of eggs of parasitic worms was counted in the fæces of a group of ewes fed on

pasture and of another group that were given a protein rice concentrate. After a year there were much fewer eggs in the fæces of the group that were given the concentrate. One group of Swiss white mice were given a stock diet and another diet that supplied more protein and calcium. Suspensions of human tubercle bacilli were injected intravenously. In the group that had the higher protein ration, the mean survival time was longer and the extent of invasion of the lungs less than in the group that had the stock diet.

Prof. A. Fleisch discussed the effect of rationing in Switzerland as a large-scale experiment on human requirements. Up to 1943, when rations supplied little more than 2,000 calories a day to a normal adult, health improved, there was less dental caries and weights were maintained. During the period of rationing the amounts of meat in the diet fell and the amounts of potatoes and vegetables rose; the amounts of calcium, niacine, vitamin B_1, and ascorbic acid in the diets were considerably higher than before. When the number of calories fell below 2,000 in 1944 and 1945, weights of adults and children fell, and the hæmoglobin level of a sample group, which was studied over the whole period, fell. Prof. Fleisch thought that the League of Nations standard of requirements for a sedentary adult is unnecessarily high.

Dr. B. S. Platt discussed practical applications of the knowledge of nutrition and the social aspects of nutrition in villages of Central and West Africa. The estimated expenditure of energy was low and approximately equal to consumption. The yields of food crops were low and would barely supply the calories required. In West Africa nutrition suffered more, as groundnuts were grown for sale, and less food could be grown for home consumption. Much time was lost in collecting and preparing food and in drawing water. The problem is to build a new social structure in place of the native structure which is breaking down.

INTERNATIONAL COMMISSION ON LARGE DAMS

CONGRESS IN SWEDEN

THE third Congress of the International Commission on Large Dams was held in Sweden during June 10–17. The opening session was held in the Stockholm Concert Hall (Konserthuset) and the closing session at the Saga Cinema, Trollhättan. At the opening session Mr. G. Westerburg, president of the Swedish Committee of the International Commission on Large Dams, welcomed the delegates from twenty-three nations, and M. A. Coyne, president of the Commission, declared the Congress open.

There were four plenary sessions dealing with the following technical questions:

(1) Critical exposition of the measurement of uplift pressures and stresses arising therefrom; M. W. Schurter, Inspecteur fédéral et chef des Travaux Publics de la Confédération Suisse, acting as general reporter.

(2) Research methods and instruments for the measurement of stresses and deformation in earth and concrete dams; M. Mary, ingenieur en chef des Ponts et Chaussées, France, acting as general reporter.

(3) The most recent precautions to avoid the formation of pipings; Prof. K. Terzaghi of Harvard University, Cambridge, Mass., acting as general reporter.

(4) Experiences arising from the testing and the actual use of special cements for large dams; Prof. B. Hellström, of the Royal Institute of Technology, Stockholm, acting as general reporter.

More than seventy papers ranging over these subjects were presented for discussion, and most of these were available before the meeting and were accompanied by summaries in French and English.

The question of upward water pressure on dams, and what allowances should be made for it, is a problem which has worried designers of new dams for a great many years. The information needed is not only the value per unit surface area of the upward pressure to be allowed in calculations, but also some idea of the extent of the area of the dam over which such upward pressure operates. Of the eleven papers submitted, three, by Harza (U.S.A.), Leliavsky Bey (Egypt) and McHenry (U.S.A.), dealt with the scientific aspects of the problem and arrived at the general conclusion that, within the limits of error of measurement, the upward pressures act on practically the whole geometrical surface in question, whatever their specific values at particular points, whether in a plane intersecting the dam, or in the plane of the foundation. Seven other papers dealt with uplift pressures from the practical point of view, five describing the experimental determination of uplift pressures in existing structures, and two dealing with the influence such pressures have on the design of masonry or concrete dams, particularly with regard to the stresses induced. On the upstream side, the value of the specific upward pressure is equal to the hydrostatic pressure of the water in the reservoir, while on the downstream side it is normally zero. Between these two extreme edges of the cross-section, the uplift pressure varies generally in a linear manner, allowing, of course, for the effect of any structural measures designed to reduce the intensity of the pressure. Needless to say, appropriate structural measures should be adopted to prevent the upward pressures becoming operative in the base of the dam, on the foundation surface, or in the body of the dam itself. The remaining paper in this group, presented by Prof. Myslivec, of Prague, dealt with the important problem of infiltration through earthwork embankments, and with the properties of suitable sealing materials for these.

Nineteen papers were submitted on the second question dealing with research methods and instrumentation. They ranged over many and varied topics such as the measurement of displacements of the soil and of earthworks, the measurement of the pressure of water contained in earthworks, temperature and shrinkage measurements, the deformation of gravity dams and arch dams, and the settlement of earth and rock fills. The reports also provided a useful comparison of the experimental methods and measuring equipment used in different countries. Of particular interest and significance were the observations of the swelling of the soil due to impregnation by water after filling the dam, made by Farnsworth (Australia), on the Nepean Dam, and by André Nizery (of France) on the Sautet and Querlédan Dams.

The phenomenon of piping and seepage provided the subject for fifteen papers in the third group. A dam may fail by piping in two different ways: either the seepage pressure exerted by the percolating water may cause a failure of the soil beneath the dam; or the soil may be removed from beneath the dam by

erosion, in which case a tunnel-shaped passage, or pipe, is formed through which the impounded water may escape, with disastrous results. It is natural that most of the papers dealt with the various precautions that have been taken to prevent such failures. Generally, the prevention of the removal of soil from beneath the dam has been achieved in one or other of three different ways, either by constructing a cut-off which would prevent the formation of springs or pipes in the subsoil and reduce the loss of water from the reservoir due to seepage; by covering, by means of a filter layer, the areas within which springs may develop, the layer being graded in such a manner that it would retain all solid soil particles without impeding the discharge of seepage water; or by tapping the flow of seepage water by a row of filter wells, thus preventing the formation of springs on the surface.

Twenty reports were submitted in the last group, dealing with experiences arising from the testing and actual use of special cements for large dams. Six of these reports dealt primarily with methods of testing cement for properties of importance for large dams, such as fineness of grinding, heat evolution and resistance to leaching by pure or slightly acidic waters, and with the properties of concrete such as extensibility and creep. A paper by F. M. Lea summarized British experience. An important paper by P. Håkanson (Sweden) dealt with the general principles for a standard specification of special cements for large dams. Nine other papers recorded experiences with the use of special cements in large dams, while the remaining four dealt with various subjects such as air-entraining agents, reactive aggregate, high alkali cement and expanding cement. The paper by R. F. Blanks and W. H. Price (U.S.A.) summarized the experience in that country with air-entraining agents in concrete. The purposeful entrainment of air in concrete improves its workability, reduces the water required for mixing, improves the durability and resistance to sulphate attack, and permits the use of less cement where strength is not a prime consideration, thus reducing heat generation. The permeability of the concrete is also not increased by air entrainment for the percentages commonly used. Air-entrained concrete is now being used in the construction and repair of large concrete dams in the United States.

On June 12 the delegates left Stockholm on two well-organised study tours which extended as far north as Harsprånget within the Arctic Circle, and terminated at Trollhättan in the south, on June 17. During the tours visits were paid to a number of power plants including those at Nämforsen, with a capacity of 45,000 kW., and completed in 1947; Forsmo, on the Angermanalven, of 70,000 kW. capacity, and nearing completion; Holleforsen, on the Indalsalven, of 120,000 kW. capacity, under construction; Harsprånget, on the River Lule 7 km. from Porjus, where the falls, constituting the largest source of water-power in Sweden, will be utilized in a power plant with an ultimate capacity of 260,000 kW.; Krangede, on the Indalsalven, built entirely in the natural rock and completed in 1936, with a capacity of 210,000 kW.; Stadforsen, also on the Indalsalven, constructed during the years 1936–40, with a capacity of 91,000 kW.; Hammarsforsen; and Vargon on the River Göta completed in 1934 with a capacity of 22,000 kW. A visit was also paid to the very interesting tunnelling operations in progress at the Hjälta plant. At Trollhättan the two power plants were visited, the Olidan plant on the Göta, the oldest State power plant in Sweden, constructed in 1910–20, and the Hojum plant, completed in 1943, with a capacity of 120,000 kW., which is constructed entirely in the natural rock formation. Both the Trollhättan stations are fed by the water from the Great Lake of Vänern.

Visits to several works were included, to the cellulose works belonging to Uddeholms A.B. at Skoghall, and to that of Svenka Rayon A.B. belonging to Kooperativa Forbundet near Älvenas; to the steelworks at Munfors Bruk belonging to Uddeholms A.B. and to the Karlstads Mekaniska Verkstad.

The opportunity was taken at Trollhättan, on June 17, of holding a meeting of the International Sub-Committee on Concrete for Large Dams, at which consideration was given to possible lines for future research. These included fundamental research into the physical structure of concrete, its elastic and plastic properties; the physical properties of concrete in large masses, such as extensibility and cracking, and means whereby the internal strain, temperature and humidity may be measured; the chemical interaction between cement and aggregates in concrete, particularly alkali reaction; surface treatment of concrete for dams and particularly by the application of vacuum treatment, and by the use of absorptive formlining materials; the properties of pozzolanas and natural cements; the preparation of a code of permissible unit stresses for use in dam design, to include a discussion of the minimum economic cement content per unit volume which is necessary to prevent concrete deterioration; and to study factors of safety in relation to computed three-dimensional working stresses.

Throughout the meetings in Stockholm and the subsequent tours the delegates were afforded the most generous hospitality by their Swedish hosts. Particularly memorable occasions were the official banquet held at Stockholm in the Town Hall, and the dinner given by the State Power Board at the Stadshotellet, Trollhättan.

NORMAN DAVEY

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, October 4

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. C. Baldwin: "The Work of a Divisional Engineer in Northern Rhodesia".

SOCIETY OF CHEMICAL INDUSTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. H. Baines: "The Photographic Latent Image".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Wilfred Thesiger: "A New Arabian Journey".

Tuesday, October 5

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Discussion on "Valves for Low-Noise Wide-Bandwidth Amplifiers" (to be opened by Mr. R. J. Ballantine and Dr. A. E. Widdowson).

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. J. H. Burn: "Fine Chemicals for Medical Use".

Wednesday, October 6

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. A. Ahlstrom and Mr. A. Ullman: "Low Value Heat Recovery".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Scientific Papers.

ROYAL AERONAUTICAL SOCIETY (at the Chamber of Commerce, Birmingham), at 7.30 p.m.—Dr. E. W. Still: "Some Aspects of Power Plant Development".

Thursday, October 7

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. Graeme N. Haldane: Inaugural Address as President.

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (at the British Council, 3 Hanover Street, London, W.1), at 6.15 p.m.—Miss Anne G. Shaw: "Applications of Motion Study, Past and Present". (The original films of Frank B. Gilbreth and modern films of Motion Study will be shown.)

ROYAL INSTITUTE OF CHEMISTRY (at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—Dr. N. Booth: "Careers for Chemists".

TEXTILE INSTITUTE, BLACKBURN BRANCH (in the Textile Lecture Theatre, Municipal Technical College, Blackburn), at 7.15 p.m.—Mr. J. Foster Beaver: "Technical Training for Industry".

CHADWICK PUBLIC LECTURE (in the Reception Room, the University, Bristol), at 8.30 p.m.—Mr. Asa Briggs: "The Public Health Act of 1948, a Forgotten Centenary".*

Friday, October 8

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Dr. H. Plimmer: "The Reaction of Maleic Anhydride with Non-conjugated Unsaturated Fatty Esters".

INSTITUTE FOR THE STUDY OF ANIMAL BEHAVIOUR (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Rev. A. E. Armstrong: "Social and Sexual Stimulation amongst Birds".

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 3.30 p.m.—Prof. R. W. Wood, For.Mem.R.S. (Johns Hopkins University): "Spontaneous Deformation of Crystals"; at 5 p.m.—Prof. S. Tolansky: "Current Investigations with Multiple-Beam Interferometry" (Charles Vernon Boys Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Informal Discussion on "Quality Control in Great Britain and the U.S.A.".

Saturday, October 9

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (at the College of Technology, Manchester), at 3 p.m.—Mr. W. S. Norman: "Fluid Friction, Heat and Mass Transfer in Turbulent Flow".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE DEPARTMENT OF PHYSICS AND MATHEMATICS, Acton Technical College, Acton—The Chief Education Officer (F/GM), Middlesex Education Committee, 10 Great George Street, London, S.W.1 (October 9).

RESEARCH OFFICER IN THE SOILS CHEMISTRY SECTION of the C.S.I.R. DIVISION OF SOILS, Adelaide—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1938 (October 23).

ASSISTANT CHEMIST AT THE DIVISIONAL LABORATORY, Manchester—The Divisional Establishment Officer, National Coal Board, North-Western Division, 47 Peter Street, Manchester 2 (October 23).

RESEARCH OFFICER IN THE C.S.I.R. DIVISION OF AERONAUTICS, Fishermen's Bend, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1633 (October 23).

UNIVERSITY POST-GRADUATE FELLOWSHIP IN THE DEPARTMENT OF ANAESTHESIA, and an ASSISTANT LECTURESHIP IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (October 30).

SENIOR LECTURER IN BIOLOGY in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.2 (Wellington, November 30).

AGRICULTURAL CHEMIST for research work on soil and other problems; an ENTOMOLOGIST who should be capable of identifying and advising on plant diseases; and a PLANT BREEDER to conduct crop improvement work, mainly on wheat; in connexion with a scheme of agricultural development in Northern Rhodesia—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LABORATORY ASSISTANT-STEWARD (male) FOR ZOOLOGY—The Head, Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3.

SENIOR LECTURER IN PHARMACEUTICAL CHEMISTRY—The Dean, School of Pharmacy, 17 Bloomsbury Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Silicosis, Pneumokoniosis and Dust Suppression in Mines. Proceedings at Conference held in London, April 1947. Pp. v+190+43 plates. (London: Institution of Mining Engineers, and the Institution of Mining and Metallurgy, 1947.) 20*s.*; to Members, 10*s.* [197

Reports of the Progress of Applied Chemistry. Vol. 31, 1946. Pp. 745. (London: Society of Chemical Industry, 1948.) [207

The Journal of the Institute of Metals. Vol. 72, 1946. Edited by N. B. Vaughan. Pp. lvii+732+80 plates. (London: Institute of Metals, 1946.) £3. [207

Quarterly Journal of Experimental Psychology. (Published for the Experimental Psychology Group.) Vol. 1, Part 1, April 1948. Pp. 52. (Cambridge: W. Heffer and Sons, Ltd., 1948.) 8*s.* 6*d.* net; annual subscription, 30*s.* [207

Scottish Council (Development and Industry). Final Report of the Committee on Plastics: Plastics in Scotland. Pp. 16. (Edinburgh: Scottish Council (Development and Industry), 1948.) 2*s.* [217

Journal of Sex Education. (Published every 2 months.) Vol. 1, No. 1, August 1948. Pp. 32. (London: Journal of Sex Education, 127 Harley Street, W.1, 1948.) 2*s.*; annual subscription, 10*s.* 6*d.* [227

House Style: Rules for Compositors and Readers. Pp. iv+52. (Edinburgh: Thomas Nelson and Sons, Ltd., 1948.) [267

Deterioration of Structures of Timber, Metal, and Concrete exposed to the Action of Sea-Water. Nineteenth Report of the Committee of the Institution of Civil Engineers, Being a General Summary of the Experimental Work carried out to date on Timber. By J. Bryas. Pp. iv+49. (London: Wm. Clowes and Sons, Ltd., 1948.) 5*s.* [267

Artificial Human Insemination. The Report of a Commission appointed by His Grace the Archbishop of Canterbury. Pp. 70. (London: S.P.C.K., 1948.) 2*s.* 6*d.* net. [277

Directory of Natural History Societies. By H. K. Airy Shaw. (Pamphlet No. 7.) Pp. 155. (London: Amateur Entomologists' Society, 1948.) 7*s.* 6*d.* [287

Anodic Oxidation of Aluminium and its Alloys. (Information Bulletin No. 14.) Pp. 61. (London: Aluminium Development Association, 1948.) 1*s.* [297

National Physical Laboratory. The Inclusion of Equivalent Metric Values in Scientific Papers. Pp. 16. (London: H.M. Stationery Office, 1948.) 4*d.* net. [297

Other Countries

National Museum of Canada. Bulletin No. 97 (Biological Series No. 26): Botany of the Canadian Eastern Arctic, Part 2, Thallophyta and Bryophyta. Compiled and edited by Nicholas Polunin. Pp. vi+574. (Ottawa: Department of Mines and Resources, 1947.) 1 dollar. [77

Australian Journal of Scientific Research. (Published quarterly.) Series A: Physical Sciences. Vol. 1, No. 1, March 1948. Pp. 119. 7*s.* 6*d.*; 30*s.* per annum. Series B: Biological Sciences. Vol. 1, No. 1, February 1948. Pp. 162. 7*s.* 6*d.*; 30*s.* per annum. (Melbourne: Council for Scientific and Industrial Research, 1948.) [157

Geophysica. No. 1. Pp. 66. No. 2. Pp. 186. (Helsinki: Geophysical Society of Finland, 1935, 1947.) [157

Rubber Research Institute of Malaya. Information Cards (No. 1: Useful General Information; No. 2: Standardizing and Coagulation of Latex; No. 3: Some Estate Chemicals and their Uses; No. 4: Defects in Rubber; No. 5: Defects in Rubber (contd.); No. 6: Manufacture of Pale Crepe; No. 7: Preservation and Testing of Latex; No. 8: Preservation and Testing of Latex (contd.).) Revised April 1948. (Kuala Lumpur: Rubber Research Institute of Malaya, 1948.) 1 dollar. [157

Report of the Scientific Advisory Board for the Year 1947. Issued under the authority of the Governing Body, Indian Research Fund Association, New Delhi. Pp. xii+209. (New Delhi: Indian Research Fund Association, 1948.) 1 rupee. [157

Spolia Zoologica Musei Hauniensis, 8 (Skrifter udgivet af Universitetets Zoologiske Museum, København, 8): Contribution to the Phylogeny of the Arthropoda—Copepoda. By Poul Heegaard. Pp. 236+27 plates. (København: Einar Munksgaard, 1947.) [157

Fieldiana. Geology Memoirs, Vol. 3, Nos. 1 and 2: The Vertebrate Fauna of the Selma Formation of Alabama. Part 1: Introduction; Part 2: The Pleurodiran Turtles. By Rainer Zangerl. Pp. 56+4 plates. (Chicago: Chicago Natural History Museum, 1948.) 1.50 dollars. [157

Naturwissenschaftliche Rundschau. Herausgegeben von Dr. H. W. Frickhinger. Jahrgang 1, Heft 1, Juli 1948. Pp. 48. (Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1948.) 2 D. marks. [197

Carnegie Institution of Washington. Publication 575: Contributions to Embryology, Vol. 32, Nos. 207 to 212. Pp. iii+266+56 plates. (Washington, D.C.: Carnegie Institution, 1948.) [197

Transactions of the American Philosophical Society. New Series. Vol. 38, Part 1: La culture et la civilisation britanniques devant l'opinion française de la paix d'Utrecht aux *Lettres philosophiques* (1713–1734). Par Prof. Gabriel Bonno. Pp. 184. (Philadelphia: American Philosophical Society, 1948.) 2.50 dollars. [197

Information for Authors, Editors and Printers. Pp. vii+40. (Johannesburg: Associated Scientific and Technical Societies of South Africa, 1948.) 2*s.* 6*d.* [197

Ministry of Commerce and Industry: Mines and Quarries Department, Geological Survey. Geology of the Barramiya Mining District. By M. I. Attia. Pp. x+76+35 plates. (Cairo: Government Press, 1948.) P.T. 75. [217

Smithsonian Institution: Institute of Social Anthropology. Publication No. 7: Cultural Geography of the Modern Tarascan Area. By Robert C. West. Pp. vi+77+14 plates. (Washington, D.C.: Government Printing Office, 1948.) 75 cents. [267

Bulletin of the American Museum of Natural History. Vol. 91, Article 1: The Beginning of the Age of Mammals in South America. By George Gaylord Simpson. Part 1: Introduction; Systematics: Marsupialia, Edentata, Condylarthra, Litopterna and Notioprogonia. Pp. 232+19 plates. (New York: American Museum of Natural History, 1948.) 3.50 dollars. [267

Das Schrifttum der Bodenkultur. Zusammengestellt in der Bibliothek der Hochschule für Bodenkultur. (Published every second month.) Jahrgang 1, Heft 1, Mai 1948. Pp. 36. (Wien: Österreichischer Fachzeitschriften-Verlag, 1948.) Subscription, 15 Austrian schillings; 7 Swiss francs. [267

Smithsonian Institution: Bureau of American Ethnology. Bulletin 143: Handbook of South American Indians. Vol. 3: The Tropical Forest Tribes. Pp. xxvi+986+126 plates. (Washington, D.C.: Government Printing Office, 1948.) [267